FBIS-CST-96-006
30 April 1996

FOREIGN BROADCAST INFORMATION SERVICE

FBIS Report —

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FBIS-CST-96-006 *30 April 1996*

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'Super-863 Plan' To Target S&T in the 21st Century

96P30159A Beijing RENMIN RIBAO in Chinese 15 Feb 96 p 5

[Article by Wen Hongyan; "The 'Super-863 Plan' To Target S&T in the 21st Century Mapped Out"]

[FBIS Summary] The State Science and Technology Commission has laid out the "Super-863 Plan" (also called "S-863 Plan"), the State high-tech research and development (R&D) strategic plan, to bring China's high technology into the 21st century. The plan's goal is to achieve the government's S&T strategy of "surpassing development, promoting innovation, systemizing integration, and demonstrating motivation." In order to further boost China's national economy through promoting China's industrial technology and bringing the technology to a surpassed development, the plan will be focusing on the development of agriculture, information, and software. Although the "Super-863 Plan" is closely related to the "863 Plan," the difference between the two plans is that the "863 Plan" is aimed at catching up to the world's high-tech forefront, and the "S-863 Plan" is aimed at bringing China's important high-tech arena closer to the world's standards to revitalize China's overall national strength.

China's 'Ninth 5-Year' S&T Plan

96P30159B Beijing RENMIN RIBAO in Chinese 15 Feb 96 p 5

[Article by Chen Zujia; "The State Science and Technology Commission To Implement 15 Most Important Projects in the 'Ninth 5-Year Plan' Period"]

[FBIS Summary] The State Science and Technology Commission (SSTC) announced recently that in the "Ninth 5-Year Plan" period, the state science and technology (S&T) plan will focus on 15 top priority projects and put six agricultural S&T projects on top of the agenda. The six top priority agricultural projects are: Popularization of integrated technology to be used for promoting grain production in large scale; 2) Research, development and demonstration of the technology to support the production of high-yield rice, corn, wheat, soybean, and cotton in large areas; 3) Research and development of technologies for breeding high-quality crops and the industrialized production of these new crops; 4) Research and development of technologies for raising cattle that produce more meat, cows producing more milk, pigs producing leaner meat, and chickens producing more eggs in large scale; 5) Research and development of new pesticides; 6) Research on short-term climate forecast system that is especially designed for agricultural purposes.

Also included in the plan are seven projects to expand the use of high technology to renovate China's outdated traditional industry, to boost Chinese industries' capability of innovating new technologies, and to accelerate the development of high technology and high-tech industries. The seven projects include: 1) Application and demonstration of CAD (computer-aided design); 2) Popularization and application of CIMS (computer-integrated manufacturing system); 3) Research and development of advanced technologies to be used for commercial and trade purpose; 4) Research and development of high-performance computers in the "Dawning (Shuguang)" series; 5) Research and development of high-performance digitally programmed switches; 6) Industrialization of nickle-hydrogen batteries; 7) Research and application of remote sensing, geographical information system and global positioning system (3S) technologies.

In addition, two priority projects are included in the plan as well for promoting social development, which include: 1) Research on new drugs and the industrialized production of new drugs; 2) Development of technology for building moderate-family style dwelling houses in cities and villages.

In order to achieve new breakthroughs, with the assistance of other departments and several regions, the SSTC will initiate the implementation of the 15 projects and an expert team will be established by selecting the expert scientists from industries to oversee the implementation.

State S&T Leading Group Established

96P30159C Beijing RENMIN RIBAO in Chinese 19 Mar 96 p 1

[Article by Liu Zhenying, Chen Yan, Yang Zhenwu]

[FB1S Summary] In order to implement the "Ninth 5-Year Plan" and the Long-Term Target for year 2010 through Science and Technology (S&T) advancement, the State Council established the S&T Leading Group (SSTG) on 18 March. The SSTG is composed of Li Peng, Wen Jiabao, Song Jian, Ding Henggao, Zhu Guangya, Zhou Guangzhao, He Chonglin, Zhu Lilan, with Li Peng being the group leader and Wen Jiabao and Song Jian the associate group leaders.

The mission of SSTG is to research and formulate the nation's S&T policy, to discuss and make decisions on major S&T massion and key projects, and to coordinate S&T work among S&T organizations across the nation. According to Li Peng, SSTG is helpful to the government to oversee the overall implementation of the "S&T as the first productive force," to further implement the government's strategy of "using S&T to revitalize national strength," to strengthen a unified management of S&T by the State and the Communist Party, and to further centralize the S&T manpower, resources and funding in order to further promote overall S&T advancement in the Chinese society.

China: Structural, Particle-Size Changes in Nanometer Wurtzite-Structure BN With Temperature

963A0012A Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Sep 95 Vol 44 No 9, pp 1449-1453

[Article by Ju Xin[1] [1565 2450], Su Yixi[2] [5685 1138 1585], Chi Yuanbin[3] [3069 0337 2430], Wei Kun[2] [7614 0981], and Shi Chaoshu[2] [2457 0877 3219], Department of Modern Physics, University of Science and Technology of China, Hefei 230026 (1), Department of Physics, University of Science and Technology of China, Hefei 230026 (2), and Superhard Materials National Laboratory, Jilin University, Changchun 130023 (3): "Structural Changes and Crystal Growth Characteristics of Nanometer Wurtzite-Structure Barium Nitride As a Function of Annealing Temperature"; MS received 8 Sep 93, revised 5 Apr 94; funding from NSFC]

[FBIS Summary] Ultrafine wBN (wurtzite-structure barium nitride) powder was subjected to a static pressure of 8 MPa, forming lamellar particles. Samples of this product were annealed in a tube furnace at room temperature, or at 100°, 300°, 500°, 600°, and 800° C for 10 hours. Powder X-ray diffraction analysis was performed with a D/MAX-rA rotating-target X-ray diffractometer using Cu K_α radiation at a wavelength of 0.15418 nm, with an anode potential of 40 kV and a current of 100 A. The original wBN and the annealed samples all proved to have wurtzite structure. Electron diffraction patterns were obtained with an H-800 electron diffractometer. The particle size was estimated from the peak width of the X-ray diffraction curve, eliminating instrument-produced broadening by calibration against standard samples. The diffraction patterns of the material annealed at low temperature included a background signal produced by noncrystalline material, by disordered states on surfaces and interfaces, by structural defects, and by internal stresses. With increasing annealing temperature, there was little change in peak shape, but the (100), (002), and (101) peaks became sharper. TEM photographs of the wBN indicate an average particle size of 20 to 30 nm. The samples annealed at the higher temperatures showed distinct lamellar crystals with little image contrast. They had little surface disorder and therefore exhibited distinct diffraction spots. With increasing annealing temperature, the crystal grains gradually increased in size, indicating that the crystal boundary characteristics are important to the properties of this nanomaterial.

Figures: (1) X-ray diffraction curve of wBN after annealing at 500° C; (2) TEM photographs and electron powder diffraction patterns of initial wBN and materials annealed at 100° and 500° C; (3) Instrument calibration curve; (4) Crystal size versus annealing temperature for (100), (002), and (101) planes, calculated curve. No tables.

References: 5 English, 4 Chinese.

China: Synthesis of Nanometer SiC Whiskers by Microwave Heating

963A0012B Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Oct 95 Vol 31 No 10, pp B473-B476

[Article by Dai Changhong[1] [2071 7022 5725], Zhang Jingsong[2] [1728 0513 2646], Yang Yongjin[2] [2799 3057 6651], Cao Lihua[2] [2580 7787 5478], Zhang Xianpeng[1] [1728 7359 7720], and Xia Fei[2] [1115 7236], Northeastern University, Shenyang 110006 (1), Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110015 (2): "Synthesis of Nanometer SiC Whiskers by Microwave Heating"; MS received 17 Jan 95; research supported by State Expert Committee on New Materials for High Technology]

[FBIS Summary] Silicon carbide whiskers give strength and toughness to metals or ceramics. Preparation of β-SiC whiskers by microwave heating has not previously been described. The method is fast, free of thermal hysteresis, effective, and energy-efficient. Ultrafine SiO_2 powder and either phenol-formaldehyde resin or ultrafine carbon black were reacted in a multimode-resonator microwave furnace under an atmosphere of nitrogen at normal pressure. Three different preparation procedures were used: (1) solution of phenol-formaldehyde resin in ethyl alcohol with addition of SiO_2, ball milling, oven drying, thermolysis with a temperature rise of 3 deg/min to at least 600° C; (2) hardening of phenol-formaldehyde resin at 150° C, thermolysis as above, mixing with SiO_2, milling in alcohol for 20 hours, oven drying; (3) process 2, but using carbon black instead of resin. The materials thus prepared underwent thermolysis with a temperature rise of 40 deg/min to 1180° or 1350° C, cooling, decarburization at 500° C (16 hours) and removal of SiO_2 with hydrofluoric acid. X-ray diffraction analysis clearly showed that the product was β-SiC. The VLS (vapor-liquid-solid) mechanism of growth is ruled out: no liquid was present, and the ends of the whiskers were planar rather than spherical. A vapor phase reaction between SiO_2 and CO is indicated. Whiskers grown at 1180° were uniform and long; at 1350° C an excess of gaseous SiC resulting from faster reaction produced thin but irregular whiskers. When carbon black was used, the reaction between fine solid particles proved too fast for normal whisker growth. When resin was used, a carbon film coated the silica particles, hindering growth

until gasification occurred, which produced more regular whiskers.

Figures: (1) X-ray diffraction pattern of product; (2) TEM photographs (scale 200 nm and 50 nm) of whiskers prepared at 1180° and 1350° C; (3) Morphology of SiO_2-carbon composite produced from resin. No tables.

References: 4 English, 2 Chinese.

China: Pulsed Plasma Production of Cubic BN Thin Films at Room Temperature, Low Pressure

963A0012C Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Nov 95 Vol 31 No 11, pp B489-B492

[Article by Yan Pengxun [7051 7720 8113], Yang Size [2799 1835 3419], Sun Mu [1327 3668], Ren Yufeng [0117 5148 1496], Li Bing [2621 0365], and Chen Xichen [7115 3556 3819], Institute of Physics, CAS, Beijing 100080: "Pulsed Plasma Technique for Growing Cubic Boron Nitride Film at Room Temperature and Low Pressure"; MS received 17 Mar 95, revised 19 Jun 95]

[FBIS Summary] A pulsed strong-current plasma technique of coating deposition and surface alteration, based on a coaxial-electrode plasma gun developed by the authors in 1989, which produces temperatures of 10^5-10^6 K, electron densities of 10^4-10^{16} cm^{-3}, plasma velocities of up to 50 km/s, and pulse widths of 60 μs, has now been used to produce cubic boron nitride films on monocrystalline silicon ((100) face), GCr15 bearing steel, and sodium chloride substrates. A gas mixture consisting of equal parts of B_2H_6 and N_2 was released into the evacuated discharge chamber to initiate the discharge. Most coatings were deposited at a discharge voltage of 15 kV (voltages between 10 and 30 kV for steel). The crystal size proved to be 2-10 μm on the silicon substrate, 2 μm on the steel, and 100 nm on the sodium chloride. IR spectral analysis indicated the presence of both cubic and hexagonal boron nitride phases. Deposition at 15 kV on the steel substrate produced a larger proportion of the cubic variety than deposition at 30 kV. Crystal nuclei formed on all substrates but differed in structure and appearance. The technique produces some implantation, which improves bonding. Scanning Auger electron probe analysis of the coating on steel indicated uniform concentration profiles for B and N and the presence of a thick transition layer between the coating and substrate, which improved bonding, reduced stresses between the hard film and softer substrate, decreased lattice defects, and promoted nucleation. In scratch testing of the coating on steel, separation from the substrate occurred at 43 N, much higher than for films produced by other techniques. The microhardness of this coating was 3384 kg/mm^2; it was potentially higher but was lessened somewhat by the presence of hexagonal phase. Higher voltages produce better bonding but cause surface defects; future research will concentrate on the effect of voltage. While sodium chloride has a cubic lattice like BN, the transition zone is weak and the crystals that grow on it are small.

Figures: (1) IR spectrum of coating on silicon; (2) IR spectra of films produced on steel at 15 and 25 kV; (3) Auger-electron concentration profiles of B, N, C, Fe in film on steel substrate.

No tables.References: 8 English, 2 Chinese (2 in English by same group).

China: Influence of Synthesis Pressure on Structure of FeOOH Nanosolid

963A0012D Beijing KEXUE TONGBAO [CHINESE SCIENCE BULLETIN] in Chinese 16-30 Nov 95 Vol 40 No 22, pp 2034-2036

[Article by Sui Yu[1] [7131 6735], Xu Dapeng[1] [6079 1129 7720], Su Wenhui[1,2,3] [5685 2429 6540], Xiao Liangzhi[4] [5135 5328 6347], and Li Tiejin[4] [2621 6993 3160], Solid-State Physics Laboratory, Department of Physics, Jilin University, Changchun 130023 (1), Materials Physics Center, CAS, Shenyang 110015 (2), Condensed State and Radiation Physics Branch, China Advanced Science and Technology Center (World Laboratory), Beijing 100080 (3), and Photochemical Laboratory, Department of Physics, Jilin University, Changchun 130023 (4): "Effect of Synthesis Pressure on Structure of Nanometer Solid FeOOH"; MS received 19 Dec 94, revised 27 Apr 95; research funded by NSFC"]

[FBIS Summary] Ultrafine FeOOH powder, shown by TEM inspection to have a particle size of 3-24 nm, was preformed into pellets, which were subjected to pressures of 3.0, 4.0, 4.8, and 6.0 GPa at low temperature to form a nanostructured solid. An RD/MAX-rA high-power rotating-target X-ray diffractometer was used to obtain X-ray diffraction patterns, and a Nicolet FTIR-5PC infrared spectrometer was used to obtain IR transmission spectra. The X-ray diffraction pattern of the powder not subjected to high pressure showed only extremely faint peaks, in the vicinity of 11°, 27°, 35° and 46°, which were consistent with the card values for β-FeOOH. In the material compacted at high pressures, the peaks were in the same positions and had the same width, but greater intensity. The IR spectra of the uncompacted and compacted material exhibited four main absorption peaks. Numerous secondary peaks were clearly evident in the uncompacted material and

became fainter in the specimens compacted at increasing pressures. The X-ray diffraction peaks and the main IR absorption peaks are produced by the atoms in the ordered crystal nuclei. The secondary IR peaks are produced by surface atoms with imperfect coordination and dangling bonds. In the transition zone between the crystal nuclei and the surface zone, strong lattice distortions and the attendant decrease in symmetry give rise to certain infrared vibration modes that would be forbidden in a highly symmetric material. Thus, as the powder is increasingly strongly compacted, the grain surfaces contact each other and form interfaces, so that the atoms in the surface and transition zones responsible for the secondary IR peaks can form bonds and fill their coordination spheres, with a decrease in the number of dangling bonds, so that the secondary peaks disappear. Lattice distortion also decreases.

Figures: (1) X-ray diffraction patterns for pressures of 0, 3.0 and 6.0 GPa; (2) IR spectra for pressures of 0, 3.0, 4.8, and 6.0 GPa. Tables: (1) locations and interpretations of IR absorption peaks at various pressures.

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China: Feature on State Key Laboratory for Advanced Technology of Materials Compositization, Wuhan University of Technology

963A0018A Beijing GAO JISHU TONGXUN [HIGH TECHNOLOGY LETTERS] in Chinese
Vol 5, No 11, Nov 95 inside front cover

[Article: "The State Key Laboratory for Advanced Technology of Materials Compositization, Wuhan University of Technology"]

[FBIS Translated Text] The State Key Laboratory for Advanced Technology of Materials Compositization, Wuhan University of Technology, was created with funding from the State Planning Commission. Its construction began in 1987, and it formally opened its doors to domestic and foreign contacts in 1989. State Planning Commission acceptance tests were passed in March 1990. Professor Yuan Runzhang [5913 3387 4545], the president of Wuhan University of Technology, became chairman of the laboratory committee and director of the laboratory. The laboratory now has a regular staff of 28, including 6 persons of professor or researcher rank, 8 of associate professor or associate researcher rank, and 14 of lecturer or assistant researcher rank. It also has 8 visiting research fellows and 25 adjunct part-time research personnel. It has established a mobile postgraduate facility in inorganic and nonmetallic materials and a doctoral research center in inorganic and nonmetallic materials and composites. There are now 4 postdoctoral fellows, 17 doctoral candidates, and 30 M.S. candidates.

The laboratory has three main areas of research. The first is the study of new technologies for the preparation of composites, such as self-propagating high-temperature synthesis (SHS), gradient composites, nanocomposites, microwave synthesis and processing, and new crystal synthesis techniques. The second area of research deals with new materials, primarily new-generation composites, including nanocomposites, gradient composites, ultrafine composites, and new functional materials. The third area of research deals with the principles of composite formation and materials design. The laboratory is now the exclusive performer in 50 projects for state organizations at various levels, including 4 breakthrough projects of the Eighth 5-Year Plan, 9 high-technology projects under the 863 Program, 1 project under the State Key Natural Sciences Fund, 1 under the "High Objectives" fund, and 10 provincial ministry-level projects.

The laboratory's most important recent accomplishments are the following. (1) Self-propagating high-temperature synthesis (SHS) technology. In this field, it has completed several dozen SHS-based process studies on metal-ceramic composite systems, including: the development and verification of an ignition model of a solid-solid system; the verification of a synthesis model involving combustion of the second kind; the development of an experimental SHS system that is at the state of the art nationally and internationally; and, building on its investigation of the mechanisms of SHS, the development of the SHS-QP ("SHS-quick pulse") dense materials preparation apparatus, also at the world state of the art. (1) Metal-nonmetal gradient composites and functionally gradient materials (FGM). The laboratory has taken the lead nationally in system studies of various techniques for preparing FGMs, such as powder lamination, plasma spray technology, plasma vapor-phase deposition, and SHS; and it has used the techniques to develop FGMs such as MgO-Ni, ZrO_2-Mo, TiB_2-Al, Al_2O_3-Al, Ni-Ni_3Al-TiC-SiC, and Ti-TiC-SiC materials with thermal stress relaxation. It is now a national leader in certain areas of FGM design and fabrication. (3) Nanocomposite techniques and materials. The laboratory has created equipment that uses the plasma vaporization and condensation technique for the preparation of nanoscale powder materials, and also in-situ cold compaction equipment for the preparation of nanomaterials. It has used this equipment to produce TiN-Ni nanometer powder with controllable particle size between 8 and 30 nm and with a purity of up to 99.7 percent and also to produce Ti-Ni nanoscale bulk crystal material with a relative density of 98.5 percent. (4) Microwave sintering and synthesis. Having led the way

in developing a 5-kW microwave sintering system, the laboratory then developed a 20-kW continuous-line microwave sintering system and pioneered its adaptation for practical use. (5) Development of crystalline materials. As a result of its research in the crystal chemistry of niobates, it discovered a series of doped niobate crystals with excellent application potential, including six that have now been registered on cards by the International Diffraction Center and that have won awards. It used a unique, state-of-the-art impurity-free magnetically suspended cold crucible technique to develop Tb-Dy-Fe monocrystals.

The laboratory has 18 major pieces of equipment valued at 100,000 yuan or more, including a multipurpose monocrystal growth system and a scanning tunneling microscope (STM) imported from the UK, and an MTS, Inc. ceramics testing system and hot isobaric static-pressure unit imported from the United States. It has itself developed major equipment, including the SHS-QP dense material fabrication system, a nanomaterials preparation system, a high-temperature chemical vapor deposition (CVD) system, a continuous-line ceramic sintering system, and a high-temperature plasma spray system. In addition, it has access to the more than 30 major pieces of equipment at Wuhan University of Technology's materials research and testing center.

The laboratory recently initiated extensive professional exchange and cooperation with institutions of higher learning, research organizations, and manufacturers in China and abroad. It has signed cooperative agreements with Tohoku University in Japan, with the University of California at Davis in the US, the Institute of Structural Macrodynamics in Russia, and the Alamutu [phonetic] Combustion Research Institute in Kazakhstan, and has established professional ties with such renowned laboratories as the Brookhaven National Laboratory, Bell Laboratories, and the IBM Laboratories in the United States. In addition, it has created a system of professional exchange and cooperative research with Qinghua University, Shanghai Jiaotong University, United University of Sichuan, and Huazhong (Central China) University of Science and Technology (HUST). More than a dozen Chinese academics have been visiting researchers at the laboratory, and in addition, the laboratory has contracted extensive ties with manufacturing entities in China in order to convert research results into productive capabilities. It has established horizontal cooperative research and development ties with the Wuhan Iron and Steel Works and the Zhuzhou Hard Alloys Corporation.

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Taiwan: Characteristics, Fabrication of BPSCCO Superconducting Tapes

96P30169A Taipei TS'AI-LIAO K'O-HSUEH [CHINESE JOURNAL OF MATERIALS SCIENCE] in Chinese Dec 95 Vol 27 No 4, pp 241-248

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[FBIS Summary] In this study, the influences of different starting powders on the critical current density (Jc), critical temperature (Tc), and critical magnetic field of (Bi,Pb)-Sr-Ca-Pb-Cu-O (BPSCCO) high-temperature superconducting tape are investigated. The four different starting powders used were: (A) raw coprecipitated powder, (B) powder calcined for 4 hours, (C) powder calcined for 12 hours, and (D) powder calcined for 65 hours. The Ag-sheathed BPSCCO superconducting tapes were fabricated by the combined processes of swaging, rolling, and heat treating at 830°C for 40 hours; this process was followed by analyses with XRD [X-ray diffraction], DTA [differential thermal analysis], SEM [scanning electron microscopy], and SQUID [superconducting quantum interference device] instruments. From these analyses, the highest Jc value was achieved from the starting powder calcined for 4 hours, because the powder contained the proper 2223 phase and had a significant mechanical texture after the rolling and sintering processes. Subsequently, the influences of different sintering temperatures and tape thicknesses on Jc were studied. The optimum combination (sample B35O7)—with a corresponding Jc of 2.6 x 10^4 A/square cm—was obtained from 0.07-mm-thick tapes calcined at 835°C for 40 hours; magnetic field range was -1 Tesla to +1 Tesla.

Six figures, not reproduced, show XRD patterns for the four different starting powders, the magnetic hysteresis curves (-1 T to +1 T) for the four superconductors, an SEM photograph of the type-B superconductor sintered at 830°C for 40 hours, XRD patterns for three different thicknesses of tape, a plot of resistance vs temperature (Tc is 100 +/- 3 K) for three different thicknesses of tape (sintering temperature held constant), and SEM photographs of the same three tapes. Three tables, not reproduced, list the Jc values for four different starting powders, identify the 12 samples (three different thicknesses for each of four different sintering temperatures), and list the Jc values for these same 12 samples.

References: 14 English.

China: CO_2 Coherent Laser Radar for Rendezvous, Docking of Two Spacecraft

963A0009A Beijing GUANGXUE JISHU [OPTICAL TECHNOLOGY] in Chinese Nov 95 No 6, pp 1-3

[Article by Cai Xiping [5591 0823 1627], Zhao Yuan [6392 6678], Dai Yongjiang [2071 3057 3068], and Li Chunfei [2621 2504 7378] of the Department of Applied Physics, Harbin Institute of Technology, Harbin 150006]

[FBIS Translated Text] Abstract: This paper presents a general review of the functions, design, and working principles of the CO_2 coherent laser radar (CLR) used in the rendezvous and docking (RVD) of space vehicles. An autonomous CO_2 coherent laser radar is proposed for the RVD of Chinese space vehicles. Preliminary investigations show that ranging and attitude measurement of targets using a CO_2 coherent laser radar is feasible.

I. Introduction

Rendezvous and docking (RVD) is a key technology in today's space technology and aviation development. The current trend is to use CO_2 coherent laser radar (CLR) for the measurement of the relative motion parameters needed in RVD of two vehicles. CO_2 CLR technology for space RVD was developed by the United States and ESA in the 1970s and 1980s.[1,2] China began its development of CO_2 CLR in the mid 1970s. Today, laboratory heterodyne sensing systems have been established in China. These laboratories have also assumed the responsibility of developing the photoelectric sensors for space vehicle RVD in the 1990s. A "combinational photoelectric sensor" technical plan[3] has been proposed for RVD. In this plan a CO_2 CLR will be used for the measurement of target parameters from 10 m to 20 km.

II. Functions of CO_2 CLR System

The CO_2 CLR provides a control output signal to realize autonomous RVD on synchronous or near-earth orbits. The functions of the radar[1] are:

1. Searching

The laser radar searches for the target and performs tracking once the target is found.

2. Tracking

In order to achieve dynamic control of the target, the angle and distance of the target must be acquired. By scanning and tracking the target, the CO_2 CLR provides accurate information about the angle and distance of the target, which ensures the correct RVD.

3. Docking

By providing a control output signal to the propulsion system, a laser radar can control the successful docking of the spacecraft. All the functions of the system are completed by the sensors on the receiver. The sensor system contains a local oscillator (LO), which can perform effective coherent detection and achieve high sensitivity.

III. Design of the CO_2 CLR

1. Factors to consider in system design

In order to improve the overall performance of the system and to ensure a smooth, successful docking, the following factors must be taken into consideration in design, research and development of the materials and components. The weight of the system should be as light as possible and the energy consumption should be as low as possible. In the transmission and reception process, the efficiency of the heterodyne must not be affected by the reverse scattering from the beam splitter and the anti-reflection coating. There should be a minimum number of optical components in order to reduce the loss due to absorption, scattering and surface reflection. Each subsystem of the CO_2 coherent laser must have its own cooling system in order to achieve maximum efficiency. In the meantime, the service life of the cooling system should be long enough to ensure the completion of all the missions.

2. Design of the subsystems

The CO_2 CLR system consists of the optical system, the control system, the detection system, the scanning system, and the data processing subsystem.

(1) Optical system

The CO_2 CLR system uses a CO_2 laser as the light source, and operates in the TEM_{00} mode at a wavelength of 10.6 μm. To reduce the weight of the system and to facilitate calibration, the transmit/receive mode is usually used. The pulse or continuous wave (CW) emitted by the laser is linearly polarized light with the polarization perpendicular to the incident surface. After a quarter-wave plate, the wave becomes circularly polarized light. The circularly polarized light reflected from the target, after passing through the quarter-wave plate, is converted back into linearly polarized light. The emitted light, after passing through a half-wavelength plate, has the same polarization as that of the target reflection. Heterodyne detection can therefore be performed.

(2) Scanning system

The design of the scanning system should consider simple structure, light weight, low power consumption and efficient scanning. The scanning system should satisfy the following conditions[4]: There should be no missing data in a given scanning field, the scanning time should not be too long, and the time during which the target appears in the instantaneous field of view should be sufficiently long. The modes of scanning include optical/mechanical scanning, optical scanning, electrical scanning, and scanning based on certain physical effects. The selection of the laser radar scanner should be based on the actual needs. One mode of scanning is often inadequate, and a combination of several modes may work better.[5]

IV. Operating Principles of the System

In space RVD, the first task is to determine the relative distance and attitude angles of the two space vehicles. The CO_2 CLR system can provide real-time data for the target range and attitude angle, so that accurate calibration and final control may be made.[6]

As shown in Figure 1, the alignment procedure for the two space vehicles is as follows:

(1) Reduce the non-overlapping radius r to zero, (2) Reduce the inclusion angle between the two space vehicles to zero, (3) Reduce the distance between the two matching surfaces to zero.

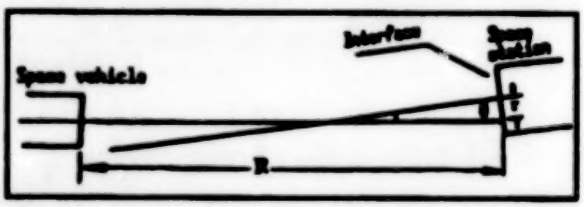

Figure 1. Alignment Operation of Two Space Vehicles

The CO_2 CLR system is installed at the front of the main vehicle. With the aid of the scanning device, the emitted light beam is spread into a conical shape centered on the main vehicle with a half conical angle β. The receiver then acquires the attitude angle of the target.

1. Range finding

One way to measure range is based on the timing of a pulse, that is, the range is determined by the time delay between the emission and reception of a pulse. Another method for determining range is to use CW. Whether the range is determined by measuring a frequency difference or a phase angle depends on the modulation mode of the emitted signal.[7] Reference 1 describes a range-finding method based on the reflected power from the target. The target consists of two coaxial objects: a ring A and a small circle B, as shown in Figure 2. Ring A consists of a set of concentric circles, on which the reflectivity at each point depends only on the distance r from the center of the target. The farther it is from the target, the greater the reflectivity. Let the ratio of the maximum and minimum reflectivity be A, then A may be determined by analyzing and comparing the reflected beam. When the scanning angle β is very small, the following approximation is true:

$$R = r/\beta$$

where β is determined by the scanning device. Error in range determined by this method is usually a few percent.

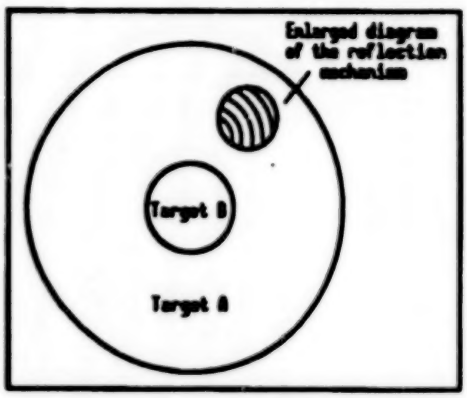

Figure 2. Circular Rendezvous Target Schematic

2. Bearing measurement

Generally, a radar determines the bearing of a target by the directionality of the antenna.[8] Most laser radars measure bearing by measuring the phase angle.[9] Other methods such as counting interference fringes can also be applied.[10] The choice of the bearing measurement method for space RVD depends on the cooperating target used in the operation.

V. Frequency Modulated Continuous Wave (FM-CW) CO_2 CLR

Based on the above considerations and measurement principles, we designed a CO_2 CLR for space RVD of China's space vehicles. The experimental arrangement is shown in Figure 3. The system uses a PZT crystal to modulate the inner cavity of the CO_2 laser to produce linear FM-CW at a working wavelength of 10.6 μm. The target range is measured by determining the frequency difference between the LO and the reflected signal. The

relationship between the frequency difference and the range is

$$R = cT_r f_b/(4\ \Delta f)$$

where T_r is the modulation period, f_b is the frequency difference, and Δf is the range of frequency modulation.

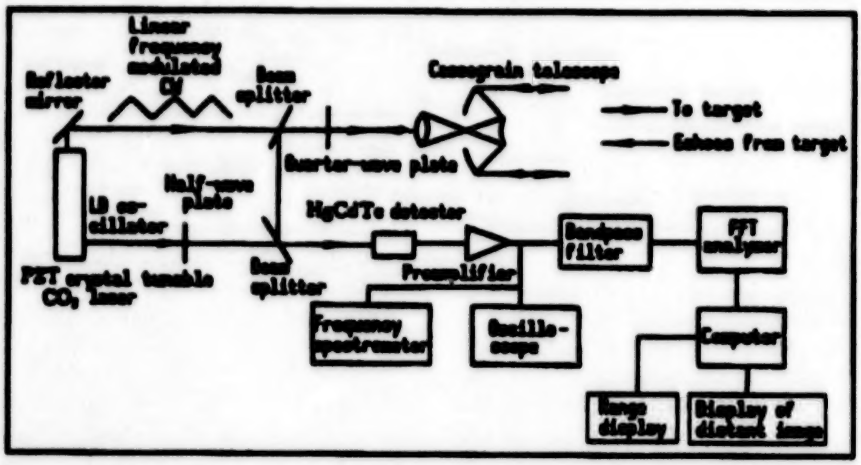

Figure 3. Block Diagram of the CO_2 Coherent Laser Imaging Experiment

The selection and development of components are now complete and laboratory testing of the heterodyne is also finished. Preliminary results showed that it is feasible to use CO_2 CLR for range finding in RVD. Work is under way for field tests of a CO_2 CLR and system development.

VI. Concluding Remarks

Real-time measurement of range and attitude is a key technology in RVD of space vehicles. Research has only begun in China for the searching, acquisition and tracking of targets using CO_2 coherent imaging laser radar. In this article, we have presented the considerations and working principles of using CO_2 CLR for space vehicle RVD. CO_2 CLR designed based on the above principles has been proven basically feasible in initial tests. However, the remaining problems of cooling the laser system and the bulkiness of the CO_2 laser in space applications can still seriously affect the application of CO_2 CLR in space vehicle RVD.

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China's Use of Meteorological Satellites To Detect Early Signs of Earthquakes

963A0009B Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese Nov 95 No 11, pp 3-5

[Article by Lin Changgong [6324 1603 1872], Wang Xuanji [3768 1357 0679], and Qiang Zuji [1730 4371 1015]]

[FBIS Translated Text] China conducted a 4-year study of seismic forecasting with meteorological satellite data and obtained encouraging results. Shortly before an earthquake, there is usually an increase in thermal infrared temperature of 2-5°C above the surrounding area; this temperature rise can be seen in meteorological satellite imagery. By analyzing this information, a seismic forecast can then be made. It should be noted that this method does not work for a region with cloud cover since thermal infrared cannot penetrate through the clouds.

I. Introduction

From October 1989 to December 1993, the State Satellite Meteorology Center in China has worked with the Geological Institute of the State Seismological Bureau to explore early signs in seismic forecasting using anomalous thermal IR temperature rise revealed by meteorological satellite images. There were more earthquakes in China in the first 2 years (1990-1991) than the last 2 years (1992-1993). On the whole, the experience has been rather positive and some lessons were learned along the way.

The anomalous temperature rise prior to an earthquake has been known for a long time and there were some studies by a number of authors. However, few studied the long-term behavior of anomalous temperature rise as an early sign for earthquakes, and there were even fewer reports on using meteorological satellite for the detection of anomalous thermal IR temperature rise. The authors are only aware of the work by A.G. Salman, et al., who investigated thermal IR from meteorological satellite and earthquake activities; their conclusion was that there was unstable anomalous temperature rise of the Earth's surface before an earthquake.

Remote sensing of the Earth's surface with meteorological satellites has the advantages of real time, wide view, and good synchroneity. It is ideal for monitoring the dynamic change of sudden anomalous thermal IR temperature rises in a large area. Other observation methods cannot compete. Meteorological satellites have great potential for detecting early signs of an earthquake.

II. Anomalous Rise in Thermal IR Temperature

One of the early signs of an earthquake is the sudden anomalous increase of temperature in the thermal IR channel of the remotely sensed signal in meteorological satellites. This temperature rise changes with time and place. Specific examples are listed below.

At 17:57 on 9 February 1990 (all times cited are in world time), a 5.1 magnitude earthquake occurred east of Changshu, Jiangsu. The epicenter was located at N latitude 31.6° and E longitude 121°. The quake was felt in Shanghai and Wuxi. On 6 February before the quake, we forecasted a magnitude 5 to 6 earthquake for the coastal area near south Huanghai and northern Jiangsu. The forecast and what actually happened basically agreed. The details are given below.

At 05:07 on 1 February 1990, we discovered a distinct, isolated brown area (anomalous temperature rise) in the ocean near N latitude 35° and between E longitude 121° and 122°. The area was approximately 50,000 square kilometers; the actual area was greater but part of it was cloud covered. The temperature of the area was 3°C to 5°C higher than the surrounding region. At the same time, there were also temperature rises in the middle part of the Shandong peninsula and near Taihu in Jiangsu. In the few days following 1 February, the region of temperature rise in Huanghai (Yellow Sea) increased and changed. At 11:23 on 4 February, the temperature rise region clearly expanded by more than three times towards the east and south. At 04:32 on 6 February, the Huanghai was covered by clouds and there was an east-west running cloud line (earthquake cloud) near the northern rim of the temperature rise zone. At that time the temperature rise in Shandong and Jiangsu had become very obvious. By 20:32 on 8 February, the cloud over Huanghai had diminished and the temperature rise zone had moved southward to the ocean surface east of the Bay of Hangzhou and outside the mouth of the Changjiang (Yangtze River). At this time the area had increased to 150,000 square kilometers. At 17:57 on 9 February, a magnitude 5.1 earthquake occurred.

On 7 March 1991, based on anomalous thermal IR temperature rise detected by satellite, we again forecasted that a magnitude 5 to 6 earthquake would occur within 10 days east of Taiwan in the southeast ocean. On 12 March a magnitude 6 earthquake actually occurred in Tainan (N latitude 23°, E longitude 120.3°). Another example was our forecast, based on anomalous thermal IR temperature rise detected by meteorological satellite, for a magnitude 4 earthquake between 17 April and 4 May in the Taiwan Strait and for a magnitude 5 to 6 earthquake in the ocean east of Suau, Taiwan, or in the vicinity of the Ryukyu Is. The report was to be followed

by updates if the thermal IR temperature rise characteristics further developed or changed. As it turned out, a magnitude 6.8 earthquake occurred in the ocean southeast of Hualian (N latitude 23.8°, E longitude 121.7°). These two forecasts were basically successful.

The early-sign thermal IR characteristics for the 6.0 earthquake in Tainan and the 6.8 earthquake southeast of Hualian were different from each other, as described below.

In early March 1991, an anomalous thermal IR temperature rise was detected by meteorological satellite in the central and southern part of the South China Sea. The temperature rise zone was rather large and sometimes moved northward to Bashi Channel and the southern tip of Taiwan. On 7 March the false color image of the thermal IR channel from the satellite showed a large temperature increase in western Taiwan plains; the color was red to purple. Scattered temperature rises, indicated in red, appeared in the coastal area of Fujian and Guangdong. The most prominent and largest temperature rise was in the region south of the 20° latitude line in the South China Sea. On 7 March the lower left region of the image was red. On 8 March the temperature rise zone in the South China Sea had clearly moved north to the ocean south of Taiwan. In 24 hours the temperature rise zone moved more than 200 kilometers to the north and the ocean temperature increased by 1°C to 2°C in some isolated spots. The temperature rise zone on the west Taiwan plains had also expanded and become more prominent. On 8 March the map turned red and purple, indicating a temperature rise of 3°C to 4°C. The coastal area of Fujian and Guangdong had also increased by 1° to 2° in thermal IR temperature. A large 100-kilometer-wide band of temperature rise ran parallel to the coast line. On the afternoon of 9 March, some isolated hot spots were observed in the ocean southwest of Taiwan. Temperature further increased in Taiwan Strait, Bashi Channel, and Balingtang Strait, and in Tainan and Kaohsuing. In the days following the 9th, not many activities were observed, but a magnitude 6 earthquake occurred east of Tainan on the 12th.

Thermal IR data obtained from the meteorological satellite on 13 April 1992 showed a temperature increase over the Okinawa trough; a small local temperature rise also appeared on the ocean northeast of Taiwan. On 15 April, a small local temperature rise also appeared on the ocean southwest of Taiwan. On 16 and 17 April the false-color image of thermal IR showed that the temperature rise over Okinawa trough had joined with the temperature rise northeast of Taiwan. At 18:23 on 16 April, a 200-kilometer-long zone of temperature increase was detected. The zone extended from the ocean west of Okinawa toward the southeast. By the afternoon of the 17th, all the temperature rise zones had grown and developed, and a large area on the thermal IR image had turned red. The temperature rise in the Taiwan Strait had slightly extended toward the north and east, and the west end of the temperature rise in Okinawa trough had joined with that to the south of Ryukyu Is., thus greatly increasing its area. On 17 April the temperature over Okinawa trough, Taiwan Strait and Taipei rose by 2° over that of the 16th, the temperature in the plains in western Taiwan rose 2°C to 3°C, Okinawa had the largest temperature rise of 4°C, and the temperature in the coastal areas of China also rose 1°C to 2°C. Of particular significance was that the isolated temperature rise in the ocean northeast of Taiwan had further increased on the 17th and extended in area to south of Hualian. This led to a 6.8 magnitude earthquake in the ocean southeast of Hualian on 20 April.

III. Early Signs of Earthquake

Sudden and anomalous temperature rise in the thermal IR region in satellite images is an early sign of an earthquake. The temperature increase is different from the routine temperature rise due to terrain or the temperature rise due to weather. Sudden temperature rises prior to a quake indicate that the concentration of stress has caused microcracking of the rocks and the connection of new and existing cracks. Gases trapped in the rocks, such as CH_4, CO_2, H_2O, and H_2, escaped to the surface. Major fissures in the Earth's crust caused great amounts of gas to escape. These gases absorbed solar radiation and infrared radiation and reflection from the Earth, causing a local greenhouse effect, thus leading to a temperature rise of the Earth's surface and the bottom layer of the atmosphere in the earthquake impending region. Specific characteristics of the sudden anomalous temperature rise include the following:

1. The temperature rise zones are isolated; their shapes can be circular, elliptical, strip, or ribbon. Their temperature is usually 3°C to 5°C higher than in the surrounding region.

2. The size of the temperature rise changes with time.

3. A temperature rise may begin 15 to 20 days before the quake, but mostly occurs 5 to 7 days before the quake.

4. The mode of temperature rise can be classified as steady or pulsed. The steady mode refers to a continuous rise of temperature until the quake. The pulsed mode refers to the fluctuation of temperature as it rises.

IV. Evaluation of the Early-Sign Forecast

The table below evaluates the three factors of earthquake forecast: time (T), location (L), and magnitude (M). The tabulation is based on actual earthquake data.

No.	Location	Magnitude	Date	Forecasted starting date	Factors	Evaluation		
						Correct	Basically correct	Incorrect
1	East of Changshu, Jiangsu	5.1	10 Feb 90	6 Feb 90	T L M	T M	L	
2	Gonghe, Qinghai	7.0	26 Apr 90	17 Apr 90	T L M	M	T L	
3	Deep ocean NE of Japan	6.0	11 May 90	11 May 90	T L M	T M	L	
4	Ocean SW of Taiwan	5.4	23 May 90	21 May 90	T L M	T L M		
5	Haienteo Is. E of Taiwan	5.4	4 Jul 90	27 Jun 90	T L M	T M	L	
6	Shahe, Beijing	4.0	22 Sep 90	14 Sep 90	T L M	T L M		
7	Xinjiang, S of Ertix	5.4	28 Sep 90	26 Sep 90	T L M	T		L M
8	Ryukyu Is., Ocean E of Taiwan	5.5	1 Oct 90	22 Sep 90	T L M	T L M		
9	Tianshi, Gulang, Gansu	6.2	2 Oct 90	No forecast				Missed
10	Yixian, Shanxi	5.1	30 Jan 91	No forecast				Missed
11	Kalping, Xinjiang	6.5	25 Feb 91	No forecast				Missed
12	Artux, Xinjiang	5.4	7 Mar 91	28 Feb 91	T L M	T M	L	
13	E of Tainan, Taiwan	6.0	12 Mar 91	7 Mar 91	T L M	T M	L	
14	Datong, Shanxi	5.8	25 Mar 91	No forecast				Missed
15	E of Datong, Shanxi	5.4	1 Apr 91	29 Mar 91	T L M	T L M		
16	Awat, Xinjiang	5.0	3 Apr 91	27 Mar 91	T L M	T L	M	
17	Ryukyu Is. Ocean E of Hualien, Taiwan	6.0 5.0	14 Apr 91 26 Apr 91	14 Apr 91 14 Apr 91	T L M		T L M	
18	Tangshan, Hebei	4.7 5.1	29 May 91 30 May 91	9 May 91 19 May 91	T L M	L M	T	
19	Hejing, Xinjiang	5.2	6 Jun 91	9 May 91 27 May 91	T L M		T	L M

No.	Location	Magnitude	Date	Forecasted starting date	Factors	Evaluation		
						Correct	Basically correct	Incorrect
20	Abaa Zuoqi, Inner Mongolia	5.0	16 Jun 91	9 May 91 27 May 91	T L M		T M	L
21	Minfeng, Xinjiang	5.3	17 Jun 91	9 May 91 27 May 91	T L M		T	L M
22	Luanxian, Hebei	4.6	27 Jul 91	25 Jul 91	T L M	T L M		
23	Hejian, Hebei	4.3	9 Aug 91	8 Aug 91	T L M	T M	L	
24	Xingtai, Longyao, Hebei	4.7 4.6	21 Aug 91 22 Aug 91	29 Jul 91	T L M	T L M		
25	Sonid Youqi, Inner Mongolia	5.4	30 Sep 91	No forecast				Missed
26	Bashi Channel	5.4	10 Feb 92	Jan 17 92	T L M	T M	L	
27	Ocean outside Hualian	6.8	20 Apr 92	16 Apr 92	T L M	T L M		
28	Ocean outside Hualian	4.6 4.5	1 May 92 4 May 92	30 Apr 92	T L M	T L	M	
29	North of Lhasa, Tibet	6.5	30 Jul 92	No forecast				Missed
30	SW of Bishkec, Kirghizstan	7.5	19 Aug 92	4 Aug 92	T L M	T M	L	
31	Nansha [Spratleys] & Dongsha Is.	5.9	14 Sep 92	19 Aug 92	T L M	M	T L	
32	Puer, Yunnan	6.3	27 Jan 93	No forecast				Missed
33	Lhasa, Tibet	6.6	20 Mar 93	23 Feb 93 16 Mar 93	T L M	T M	L	
34	Hokkaido, Japan	6.6	8 Aug 93	18 Jul 93	T L M	L M	T	
35	Hoshijo Shima (Island), Japan	6.1	1 Sep 93	12 Aug 93	T L M	T L M		
36	Ruoqiang, Xinjiang	6.6	2 Oct 93	No forecast				Missed
37	Qilian, Qinghai	6.0	26 Oct 93	No forecast				Missed

Note: In addition to the above forecasts, we also ruled out the possibility for magnitude 5 earthquake in Beijing area in October 1992 and magnitude 5 to 6 earthquake in Datong area.

V. Conclusion

1. To summarize, using satellite monitored sudden anomalous thermal IR temperature rise as an early sign for forecasting earthquakes seems to work fairly well and has potential for development. However, it is still difficult to differentiate anomalous temperature rise from regular temperature rise. Generally the identification is easier when the underlying structure is uniform, but the terrain of western China is very complex, which makes it difficult to identify isolated anomalous temperature rises. New ways to identify early-sign anomalous temperature rise must be investigated based on further research and past experience.

2. The thermal IR radiation of existing meteorological satellites cannot penetrate clouds; as a result, temperature rise of the Earth's surface cannot be detected when there is cloud coverage. In the rainy season there is cloud coverage almost every day. In the western plateau of China, there are often local convective clouds in the afternoon. These clouds can affect the identification and continuous monitoring of anomalous temperature rises of the Earth. In the future, a microwave channel should be added to the meteorological satellite to monitor the temperature of cloud-covered Earth surface.

Update on China-Brazil Earth Resources Satellite (CBERS) Projects

963A0026A Beijing RENMIN RIBAO in Chinese 13 Dec 95 p 1

[Article by Shi Wen: "China-Brazil Earth Resources Satellite Projects Advance Smoothly"]

[FBIS Translated Text] The cooperation between Brazil and the People's Republic of China is reflected in the China-Brazil Earth Resources Satellite (CBERS) project. It is specified in the project that two remote-sensing satellites will be built jointly by China and Brazil, and these satellites will be launched into orbit by Chinese launchers. In addition, there will be another mini-satellite entering into the orbit with CBERS-1. Brazil is funding the project and [Brazil's] National Institute for Space Research (INPE) is working with universities on the development of this mini-satellite.

While Brazilian President Jose Sarney was visiting Beijing in August 1988, INPE of the Brazil Ministry of Science and Technology signed a cooperative agreement with the Chinese Academy of Space Technology (CAST) to implement the CBERS project. A letter of agreement was signed by the foreign ministers of the two countries to support the cooperation.

In this bilateral cooperation, China has expressed its interest for the experiences and achievements that INPE obtained in remote sensing technologies.

The fundamental motive of Brazil is to unite its capability in aerospace technology with another developing country, so as to improve the reliability of its technology. In order to develop remote sensing satellites and to compete in the space program, INPE's research programs are listed in Brazil's integrated space program. Brazil's cooperation with China will allow the tasks to be carried on continuously.

The CBERS project will allow China and Brazil to sell image information taken by the satellites to international users. The CBERS satellites are highly competitive satellites in the market; they have different remote sensors for providing a variety of functions.

The project is the most valuable cooperative task between China and Brazil; it is also expected to initiate the relationship between the two countries. The is the first Sino-Brazilian cooperation between the two "strategic partners" in the high-tech field which has been dominated by developed countries.

Nonetheless, due to an unstable economy in Brazil since the signing of the bilateral agreement in 1988, funding for the project was affected and the project was delayed. In May 1993, Chinese Foreign Minister Qian Qichen visited Brazil and signed a supplemental agreement to confirm the collaboration. In November 1993, Chairman Jiang Zemin visited Brazil and took a tour of Brazil's INPE; Jiang was welcomed by Jose Israel Vargas, Brazil's Minister of Science and Technology. Since then, China and Brazil have entered a new stage of cooperation.

The progress of the CBERS project will help Brazil's other technology sectors get involved with the high-tech field. The integration, installation and testing of CBERS-2 will be carried out in the INPE laboratory. Brazil is the investor of the project and is responsible for controlling and tracking of the satellite in orbit. The INPE laboratory has signed a labor contract with the Chinese Launching, Control and Tracking Center, State Commission of Science, Technology and Industry for National Defense [COSTIND or NDSTIC]. The contract specified cooperative conditions for tracking and control.

At the end of September this year, the two countries discussed a proposal for the expansion of the CBERS project. The proposal calls for two additional satellites to be made jointly, so as to guarantee continuous information supply to users beginning in the year

2,000. In addition, the proposal also assures the CBERS satellites will be competitive in the international market.

China/Brazil: S&T Minister Discusses CBERS Project

96SM0167C Rio de Janeiro JORNAL DO BRASIL in Portuguese 12 Dec 95 p 9

[Article by Jose Israel Vargas, minister of science and technology: "Brazil-China Space Agreement"]

[FBIS Translated Text] At the end of 1997, we will launch the first Chinese-Brazilian remote sensing satellite (CBERS-1) from the Chinese base in Xichang.

This sophisticated technology will enable us to photograph areas of Brazilian territory as small as 20 square meters from an altitude of 778 kilometers and with extreme clarity. We have been using satellite images for over two decades, but only now, thanks to the CBERS (China-Brazil Earth Resource Satellite) Project and an investment of $150 million, are we going to master that space technology, which is one of the priority sectors in the current administration's science and technology program.

The agreement, which was signed in 1988, will be expanded as a result of new talks between President Fernando Henrique Cardoso and Chinese authorities during Cardoso's visit to that country. The CBERS project calls for building and launching two remote sensing satellites, but there is a good chance that we will negotiate the development of two more satellites, and that will mean strengthening our presence in the international market for images obtained by satellites scanning the earth.

At the moment, we are signatories to and are utilizing to very great advantage the imaging service provided by the Landsat V (United States), Spot (France), and ERS-1 (European consortium) satellites. But CBERS-1, now under construction in China under our supervision and that of the Chinese Academy of Space Technology, will outdo that entire generation of satellites in several basic respects. It will incorporate, within a single system, three sensing modes providing resolutions of 20, 80, and 260 square meters.

Besides that technological leap, we are increasing our strategic know-how: we are participating in engineering projects and training our technicians, especially those from the INPE (National Institute of Space Research), which has one of the best staffs and the most sophisticated space technology in the Southern Hemisphere. There have already been more than 30 technical missions to China, and some of the tests and projects in connection with CBERS-1 are being carried out at the INPE in Sao Jose dos Campos. Indirectly, the CBERS project is leading to technological progress in the space area by the Brazilian private sector. In short, our participation in the project amounts to 30 percent, and we will have complete control of the satellite when it is flying over our territory. Our share of the partnership may grow to 50 percent, depending on the outcome of the talks held during the presidential visit to China.

There are also additional scientific advantages. When it is launched, CBERS-1 will have at its side, in the nose cone of the Chinese Long March rocket, a microsatellite for scientific research. In that orbit, gravity is canceled out, thus providing a new field for modern scientific experiments. From the commercial point of view, this cooperation agreement opens up new and, until recently, unimaginable prospects in the international market for satellite imaging, a market currently estimated to be worth $6 billion. Brazil and China are discussing the formation of a partnership to meet a demand that could amount to as much as 15 percent of that market in a highly favorable scenario of shrinking supply. Landsat VI exploded recently during launch, and the current Landsat V is at the end of its useful cycle.

The benefits are obvious. We are still poorly acquainted with our vast territory. With CBERS, we will improve our monitoring of natural resources in such areas as river basins, mineral deposits, and—a momentous and important matter—the burning of forests in the center-west and on the new agricultural frontier on the edge of the Amazon region. Another goal is to disseminate methods for land-use planning in connection, for example, with the Agrarian Reform Program—through an agreement recently signed with INCRA [National Land Reform and Settlement Institute]—and for that purpose we will have a data bank of satellite images going back 20 years and providing a visual "memory" of the occupation and cultivation of national territory.

Another extremely important social benefit, this one linked to a knowledge of climatology and environment, is the help provided to farmers in planting their crops. A pilot experiment conducted recently with the government of Ceara (Funceme [Ceara Foundation for Hydrology and Meteorology]) was able to achieve a reduction of up to 50 percent in crop failures due to drought.

Lastly, science and technology are faced with challenges posed by the tremendous Brazilian social debt that this administration has pledged to pay. Space science is one of the fields with a future, as are biotechnology, new materials, and information technology. As President Fernando Henrique Cardoso said recently, we need to "go to the next level"—that is, produce more top-quality science and technology.

The administration's plan as set forth in the PPA (Multiannual Plan) is to increase national spending on R&D from 0.7 to 1.5 percent of GDP [gross domestic product] by 1999 and persuade the business community to invest from 30 to 40 percent of the total, compared to 10 percent at present. International partnerships are fundamental if we are to achieve those

goals. In that respect, agreements with the IDB [Inter-American Development Bank] (a loan of $320 million already signed for) or the World Bank ($600 million being negotiated) and partnerships such as those being expanded with China and negotiated with India are of vital importance to Brazilian development.

China's Space Robotics Research Highlighted

963A0026B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 29 Dec 95 p 1

[Article by Chang Yuli: "China's Space Robotics Research Achieves Major Results"]

[FBIS Translated Text] Major accomplishments have been obtained on the space robotics research undertaken by Harbin Institute of Technology (HIT). Recently, experts in this field witnessed a demonstration of space robotics at the site.

According to the Eighth 5-Year Plan, HIT is responsible for the development of the ground-experiment-platform simulation system, the master-slave control and remote control system, and the multiple-sensors artificial gripper system for the space robotics program. Through detailed design and repeated experiments, R&D personnel have overcome the technical problems and come up with a design complying with requirements.

The successfully developed simulation system can be used in the design and dynamic simulation of space robotics and can shorten the design cycles and enhance the reliability of the robotics. The successfully developed bidirectional-reaction remote control system features interactive and shared control functions; it is highly accurate with advanced structures, allowing astronauts and ground station personnel to perform remote operation. In addition, the artificial gripper system uses laser technology to measure distances and features 6-dimensional torque sensors and locking devices; it can be used in circuit board component insertion, object moving and floating object tracking. The above achievements can be used in industrial robotics, military robotics and in the field of industrial automation.

China: Update on DFH-3 Satellite

963A0026C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 9 Jan 96 p 3

["Another DFH-3 Satellite Hopefully To Be Launched"]

[FBIS Translated Text] Implemented by the 39th Institute of the Ministry of Electronics Industry and installed by China Electronic Systems Engineering Corporation, the ground monitoring and control system located at Beijing TTC and M station for the "Dong-Fang-Hong 3" satellite (DFH-3, also known as Chinasat-6) has been accepted by the Directorate General of Telecommunications (DGT), China Broadcast Communications Satellite Corporation (CBCSC), and Beijing Design Institute of the Ministry of Posts and Telecommunications. According to the experts involved with the project, if all goes well, it is hoped that the satellite can be launched by a Long March-series launch vehicle at Xichang, Sichuan within the first quarter of the year.

DFH-3 satellite is a medium-powered geostationary communication satellite developed in China; it is also an important television satellite for the Asia-Pacific region. There were many obstacles encountered during the phases of the project. During the developmental stage, the schedule was affected due to restrictions on getting critical components from western countries; during the launch preparation stage, the launching of DFH-3 was delayed due to accidents that happened on another meteorological satellite. After all the difficulties had been resolved and the satellite launched, the control center lost control of the satellite during positioning and attitude control. Consequently, DGT and CBCSC decided to launch another spare satellite (Chinasat-6), which may be launched in the first quarter of the year.

"DFH-3," a 3-axis-stabilized communication satellite developed by China Academy of Space Technology (CAST), has 24 C-band transponders (bandwidth of 36MHz), including six 16W television transponders and eighteen 8W communication transponders; their EIRP [effective isotropic radiated powers] are respectively 37dBW and 34dBW, and orthogonal line polarization is used for polarization. The useful life of the satellite is approximately 8 years.

China's Spaceborne SAR Applications at World-Class Level

963A0026D Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 12 Jan 96 p 2

[Article by Liu Maosheng: "China's Spaceborne SAR Applications at World-Class Level"]

[FBIS Translated Text] By Reporter Liu Maosheng — Lead by remote sensing specialist Xu Guanhua (also a CAS Academician) and researcher Guo Huadong, the "863" spaceborne SAR (Synthetic Aperture Radar) applied research project was recently evaluated and accepted by a panel of experts. The research achievements indicate that China's spaceborne SAR applications are advancing to a world-class level.

Spaceborne SAR features imaging capability that is not affected by clouds, rain, weather and darkness; in addition, the radar can penetrate through certain types of

ground objects. The spaceborne SAR is an advanced earth-observation technology being rapidly developed in the 90's, and its application is wide. The research project was organized and implemented by the State Remote Sensing Institute and joined by more than 50 experts from seven organizations (including the Ministry of Forestry, CAS, Ministry of Geology and Mineral Resources, State Bureau of Oceanography, and Ministry of Water Resources). This applied research includes imaging mechanism of spaceborne SAR, information collection and processing technology, and applications in forestry, geology, mining resources, oceanography, agriculture and water resources. The assigned tasks have all been completed.

Experts believe that the research has established innovative results for SAR geometrical image models and scattering models; it has developed effective techniques for suppressing SAR image spot noise. In addition to that, multilayer grain analysis, separation of information layers, enhancement of partial parameters, extraction of linear structure, and composite technology experiments for SAR imagery and TM [Thematic Mapper] imagery have been carried out in the research. Furthermore, satisfactory results were also obtained on classifying JERS-1 SAR images (single time phase or multiple time phase) based on the B-P algorithms, and by use of the spaceborne SAR images, traces of aerolite collision was discovered for the first time in China, thus providing sound proof for planet geology. In the ocean area near Penglai, Shandong Province, ERS-1 SAR images were used for the first time in China to survey the terrain below shallow sea water. These indicate that application of spaceborne SAR is important to harbor design, selection of navigational route, ocean-wave forecasting and transportation management.

The research results provide good recommendation to the selection of optimized parameters for spaceborne SAR.

Chang Jiang (Panzhihua-Luzhou) Airborne Remote Sensing Survey Certified

963A0026E Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 25 Jan 96 p 5

[Article by Luo Hui: "Chang Jiang (Panzhihua-Luzhou) Airborne Remote Sensing Survey Certified"]

[FBIS Translated Text] By Reporter Luo Hui — The Chang Jiang (Panzhihua-Luzhou) Remote Sensing Project, an important project of the Eighth 5-Year Plan undertaken by the Air Survey Remote Sensing Center in cooperated with personnel from different units (including the 909 geological team of the Ministry of Geology and Mineral Resources; Chengdu Mountain Disaster and Environmental Institute, CAS; Chengdu Biology Institute; and the Institute of Remote Sensing Applications [IRSA]), was evaluated and passed certification today by a panel of renowned experts from various fields. Experts unanimously agreed that the survey techniques and information obtained from the project are comparable to world-class levels.

Remote sensing is a technique utilizing satellite data and images for recognizing and surveying ground objects. This technique features efficient and fast collection of data, wide coverage area and plentiful information; it is currently being used in comprehensive evaluation of land resources and environment, forecasting of natural disasters as well as city planning and administration.

The Chang Jiang (Panzhihua-Luzhou) Remote Sensing Project covers a total length of 950.45 km along the Chang Jiang River and a width of 15 km, bringing a total coverage area of approximately 30,000 square kilometers. Remote sensing has been carried out in the coverage area to identify geological and environmental conditions such as avalanche, landslide, erosion, and vegetation. The remote sensing task was completed by personnel from different units, including the Chinese Academy of Geological Prospecting Technology.

Special natural conditions have made the lower reaches of the Jinsha Jiang [Golden Sand River] to be one of the most erosive regions in the world. The erosion is reflected in avalanche, landslide, and loss of water and soil, causing more disasters to this region. The ecological disturbance and landslide problems in this region have greatly affected the Chang Jiang river basin and are drawing a lot of concern from the nation.

Therefore, this remote sensing project is an important and meaningful task. Its completion basically provides us with the types, distributions and sizes of geological disasters, as well as the current conditions of land usage.

First Sino-Foreign Aircraft Manufacturing Joint Venture Established

96P30167A Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE] in Chinese Mar 96 No 3, p 2

[Unattributed article: "China's First Aircraft Manufacturing Joint Venture Set Up in Chengdu"]

[FBIS Summary] On 12 February, one of the nation's largest aircraft-engine plants, the Chengdu Engine Company, reached agreement with the world's largest aircraft-engine manufacturer, the U.S. firm Pu Hui [i.e. Pratt & Whitney], a subsidiary of United Technologies Corp. (UTC), to form a joint venture (JV). The two parties have jointly invested $22 million to form this new

JV, called Chengdu Aite [5337 3676] Aircraft Manufacturing Ltd., now being built within the premises of Chengdu Engine Company. This is the Chinese aircraft manufacturing industry's first JV and has a limit of 50 years. The JV will import advanced foreign equipment and management techniques; the firm's basic business will be to manufacture and sell—principally on the export market—civilian-aircraft engines, gas turbines, and other high-tech products suited to its production capacity. This JV will also market engineering, design, training, maintenance, and related services.

China: FT300 Sea/Land-Use Light Aircraft Described

96P30167B Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE] in Chinese Mar 96 No 3, pp 2-3

[FBIS Summary] The Unmanned Aircraft Institute of Nanjing Aerospace University has developed a three-seat sea/land-use light aircraft, model FT300, which recently passed provincial-level certification in Nanjing. This new lightweight aircraft, over 80-percent manufactured from composites, has a completely sealed cockpit with an improved three-axis control system. Principal design and performance parameters of the FT300 are as follows:

- weight = 300-350 kg
- horizontal flight speed = 65-150 km/hr
- maximum takeoff weight = 620 kg
- continuous flight time = 3-5 hrs
- range = 300-500 km
- maximum wind for normal takeoff and landing = level 5
- takeoff range from water = 400 m
- takeoff range from land = 150 m
- landing range for dry land = 150 m
- number of test flights = 200

Disease-Resistant Crops Genetic Engineering Research at CAAS

96P30160A Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 4 Mar 96 p 1

[Article by Wang Yafen]

[FBIS Summary] In the "Eighth 5-Year Plan" period the Chinese Academy of Agricultural Sciences (CAAS) made great achievements in disease-resistant crops genetic engineering research, which include:

1) **Insect-resistant transgenic cotton.** Researchers at the CAAS artificially synthesized the large molecule of BL insect-killing toxin protein gene and a sequence of gene for controlling and ensuring the expression of the toxin gene in plants. The research team then constructed an expression vector and developed a method to examine molecules the team obtained from the transgenic plants. After tested in the field, the transgenic cotton plants were popularized. The achievement has made China the second nation in the world in the area of synthesizing insect-killing gene artificially.

2) **Yellow dwarf virus-resistant transgenic wheat.** Having analyzed the nucleotide sequence of the coating protein gene of yellow dwarf viruses and deciphered the protein gene's genetic codes, researchers at the CAAS artificially synthesized the anti-yellow dwarf virus coating protein gene and inserted it into the popularly cultivated strain of wheat in China to obtain the transgenic wheat. Now the CAAS is preserving 73 generations of the transgenic wheat. The achievement has made China the first nation in the world to obtain the virus-resistant transgenic wheat.

3) **Bacteria-resistant transgenic rice research.** Researchers at the CAAS used the most advanced gene gun technique to insert the silkworm (bombyx) antibacterial peptide into rice plants and obtained the anti-bacterial blight of rice and anti-leaf stripe of rice transgenic plants. The achievement made China the first nation in the world to solve problems encountered in breeding the disease-resistant rice.

4) **Anti-bacterial wilt disease transgenic potato research.** The CAAS researchers used the integrated computer technology and biotechnology to design and synthesize three new antibacterial peptides. The new peptides were then inserted into seven potato strains that were commonly cultivated in China. So far, three antibacterial wilts of potato transgenic plant have been obtained at CAAS.

5) **Non-leguminous plant nodule-formation and nitrogen-fixation research.** In order to establish the nitrogen fixation nodule system in non-leguminous plants such as rice and wheat, researchers first used the plant hormones such as 2,4-D and the enzymolysis techniques to induce formation of nodules in non-leguminous plants and then inserted nitrogen fixation bacteria into the above-mentioned artificially induced nodules.

6) **Breakthroughs in techniques for inducing excess ovulation in cows and improving the embryo transplant and frozen techniques.** The achievement has greatly enhanced the fertilization rate of eggs and pregnancy rate of cows.

State Key Bioreactor Engineering Laboratory Established

96P30160B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 29 Feb 96 p 5

[FBIS Summary] The Huadong (East China) Bioreactor State Key Laboratory affiliated to the Huadong Science and Technology University has officially passed the assessment and will be opening for public use. The laboratory has been renamed the "State Key Bioreactor Engineering Laboratory," because it has the highest standard in China in bioreactor research and the world's most advanced equipment and facilities for scientists to conduct research experiments.

China: PAR95 3.2-Gigaflops Massively Parallel Processing (MPP) Computer System Unveiled

963A0040A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 29 Jan 96 No 5, p 1

[FBIS Translated Text]

Dispatch filed by JISUANJI SHIJIE reporter E Xia

On Jan 17, the Aviation Industries of China (AVIC) Corporation chaired a technology appraisal meeting in Xian. At the meeting, certification was granted to the PAR95 [Massively] Parallel Processing Computer System developed by the China Aeronautical Computer Technology Research Institute (CACTRI).

PAR95 is a large-scale flexible parallel processing computer system. This system follows in the footsteps of the Galaxy II and the "Shuguang 1000" computers and is another high-performance computer system that has been independently produced in China. The system features a single-precision peak operating speed of 3.2 gigaflops and its technology meets the advanced international standards of the 1990's. This system signifies that China has reached a new plateau in high-performance computer technology.

High-performance parallel computers indicate the level of a nation's expertise in the development of computers. In addition, they provide an effective approach to solving the large computational problems that are necessary in weather forecasting, seismological analysis, computations involving air currents, and other fields. For these reasons, research on parallel computers has been a hot topic in computer circles in every country of the world since the beginning of the 1990's.

The PAR95 system which has been certified features 40 node computers and utilizes a two-dimensional mesh interconnection architecture. The node computers feature a dual CPU architecture which employs high-performance general purpose microprocessors. The node computers can handle computations and communications concurrently and feature global synchronization mechanisms. This system has auxiliary software development tools which provide full support for the writing and debugging of concurrent programs. Two noteworthy features of the high-level concurrent language are that it is independent of the system's interconnection topological structure and also independent of the physical location of the processing nodes. In addition, the concurrent language provides graphic map aids, video tools for dynamic monitoring during program execution, program optimization tools, and debugging tools to facilitate debugging at the 40 nodes. Thus the system is extremely practical and user-friendly.

China: Shenyang Computing Institute Unveils KSJ2300 Superminicomputer

963A0040B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 5 Feb 96 No 6, p 1

[FBIS Translated Text]

Dispatch filed by JISUANJI SHIJIE special correspondent Wang Haitao

In a national priority project for tackling key technological problems under the Eighth FYP, the Shenyang Institute of Computing Technology of the Chinese Academy of Sciences (CAS) has undertaken a project entitled "Research on the KSJ2300 Superminicomputer System." The project was appraised for its technology and easily earned certification on 25 January. The experts on the Appraisal Committee unanimously agreed that the successes attained in this project show that China has made new breakthroughs as it follows hard on the heels of developments in international 64-bit Alpha [microprocessor] architecture technology and reduced instruction set computing (RISC) technology. The gap between China and the developed countries in the area of minicomputer design has thereby been narrowed.

In light of the situation in China's computer manufacturing industry, particularly the practical limitations imposed by China's backwardness in the manufacture of key chips compared to the developed countries, the Shenyang Institute of Computing Technology has chosen a "quick start" approach combining already existing systems with independent development of certain components. That is, advanced computer system boards have been imported from abroad while measures have been taken to select the best compatible cards and accessories in China, thus forming a complete computer system. Moreover, the institute has concentrated its efforts on developing those hardware and software products and technologies that foreign countries either do not have or which are not available domestically. They have deepened the work of keeping up with technological developments while pioneering new technologies and have independently developed a high-performance superminicomputer, its auxiliary graphics processing subsystem, a 64-bit KSJ2300 CPU system board and a KSJ2300 graphics card. Through its hard work the institute has made progress in mastering advanced technologies such as the distinctive design demands of RISC and the demands made on computer design by a high frequency operating environment; that is, a frequency greater than 100 MHz. Thus the institute has given full

play to the innovative ability of China's technical personnel.

The especially gratifying fact about the KSJ2300 superminicomputer system is that the performance that it delivers for the price far exceeds the performance/cost ratio of similar foreign products. According to an analysis by experts, the KSJ2300 superminicomputer system's performance is no different than that of similar foreign imports as they arrive "in the box"; however, its price is 30-50% less than that of these similar imports. Therefore there is a wide vista of potential applications for this system and it will be extremely competitive in domestic and foreign markets. At present, this computer system is currently being used by the Shenyang Commodity Exchange and the Northeast China Power Administration Authority. Direct economic benefits exceeding 1 million RMB have been realized by the use of this system. It also has a broad range of applications in transaction processing and office automation as well as engineering design applications in the energy resource, transportation, finance, communications and business sectors.

China: Shenzhen Firm Markets DAM Jingang Mold-Resistant Floppy Disk

963A0040C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 5 Feb 96 p 7

[FBIS Translated Text]

Dispatch filed by KEJI RIBAO reporter Huang Huaizi

At the recently concluded Chinese Exhibition of Electronic Information Applications, the DAM Jingang mold-resistant floppy disk was received with interest by those inside and outside the industry. The floppy disk is produced by the Shenzhen Leidi Science and Technology Industrial Corporation. According to a spokesperson from the China Association of Magnetic Recording Industries, in sample tests conducted in September of 1995, the DAM Jingang mold-resistant floppy disk (5.25") was the only floppy disk product on the market to earn a Name Brand Merchandise National Excellency Award. In a meeting convened in June 1995 for the dissemination of technological research achievements, the State Science and Technology Commission (SSTC) announced that this floppy disk represents a major breakthrough in world floppy disk production technology.

According to informed sources, the DAM Jingang mold-resistant floppy disk is manufactured using a new diamond material and a new diamond coating fabrication technology, both of which have received Chinese patents. By means of a man-made diamond atomic crystalline coating that is deposited on the surface of the floppy disk's core, the magnetized material is completely isolated from the atmosphere, thus protecting the data on the disk from water, oil and grease contamination, and mold. If this floppy disk is immersed in water or oil for 24 hours, the data stored on it will not be lost. The coefficient of friction on its surface is 1/7 that of ordinary floppy disks. Its service life is more than five times as long as similar domestic and foreign name brand products.

At present, most of the products on the domestic floppy disk market are imports; more than 100 Chinese floppy disk manufacturers have closed or are on the verge of closing and only about a dozen are still in production. Even though the imported floppy disks are popular among Chinese consumers, the great majority of these floppies do not have a protective coating. The data on these disks easily can be lost due to external environmental factors. Moreover, these disks quickly wear out with repeated use, causing the tracks to be damaged and making it impossible to read from or to write to the disk. Not only does the Jingang mold-resistant floppy disk avoid these drawbacks, because of its exclusive crystalline gold-colored coating the disk is also difficult to imitate.

Floppy disks are consumable goods and there obviously is a large market for them. Each year about 2 billion of them are purchased on the international market and more than 100 million are purchased on the Chinese market. The pertinent data indicates that China is second to none in its floppy disk manufacturing capabilities; production capacity is as high as 3 billion disks per year.

Since the DAM Jingang mold-resistant floppy disk has been put on the market, the disk has been very well received by computer users, especially those departments concerned with banking, insurance and the archiving of information. The Jingang floppy disk has been hailed as "the Chinese people's floppy disk" and production currently stands at between 1 million and 3 million disks.

The data concerning floppy disk imports into China and exports from China published by the General Administration of Customs indicates that, in the past few years, in terms of the overall trend, floppy disk imports into China are declining. Nevertheless, almost 1 billion floppy disks are still imported annually. In 1994, the European Union issued a floppy disk anti-dumping decision directed at China that effectively took the profit out of China's floppy disk exporting business. As a result, a large number of floppy disks have been diverted

back into China, thus greatly intensifying competition in the Chinese market.

China Sets Ninth FYP Targets for CAD

96P30158A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 13 Feb 96 p 1

[Article by reporter Zheng Qianli]

[FBIS Summary] Beijing, 12 Feb — China has formulated the "Ninth 5-Year Plan Targets for CAD [computer-aided design] Applications Projects Technology Development and Demonstration (CADAPTDD)." The overall implementation scheme for CADAPTDD passed the verification of experts in Beijing a few days ago.

As early as 1992, SSTC, in cooperation with important industrial departments, began to implement "CAD Applications Projects" and to evaluate and test independently copyrighted software for this purpose. SSTC also built a national CAD applications training network consisting of over 150 nodes, completed a study entitled "Developmental Research for China's CAD Applications Projects," and promulgated "CAD General-Purpose Technical Standards" for the nation.

The overall targets for CADAPTDD projects, listed in SSTC's Ninth FYP as the highest priority among priority topics, are as follows: (1) accelerate the elimination of the drawing board, (2) disseminate CAD techniques everywhere, (3) use CAD as a breakthrough point, (4) spur on China's independently creative software industry.

Specific Ninth FYP targets for the CAPAPTDD projects are as follows:

- Popularize applied CAD techniques in major industries such as machinery, electronics, construction/civil engineering, aeronautics, shipping, and automobiles.
- By 2000 [i.e. last year of Ninth FYP], disseminate applied CAD techniques to 70 percent of the nation's machinery industry enterprises.
- By 2000, disseminate applied CAD techniques to 80 percent of the nation's aeronautics, shipping, and automotive industries.
- By 2000, disseminate applied CAD techniques to 90 percent of the nation's research and design units.
- By 2000, disseminate applied CAD techniques to 80 percent of the nation's electronics industry.
- By 2000, disseminate applied CAD techniques to 100 percent of the nation's commercial architectural and civil-engineering construction industry.
- Realize commercialization of domestically made CAD systems, which are to capture 30 percent of the market for all CAD systems and to reach annual sales volume of over 1 billion RMB [$120.5 million].
- Establish several CAD software development bases and corresponding consultation services organs.
- Establish several national CAD applications project demonstration regions and industries.

China: CAD/CAM, Electronic Commerce Achievements Certified

96P30158B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 7 Mar 96 p 5

[Article by reporter Gao Ke]

[FBIS Summary] Zhejiang University's Institute of Artificial Intelligence and the China Aerospace Corporation's (CASC) CAD/CAM Center have jointly developed a [product-model-based] STEP-standard integrated CAD/CAPP/CAM system [GS-ICCC]. This system, included in the State 863 Program as one of the 15 major S&T tasks, passed the State Education Commission-organized appraisal a few days ago.

The overall implementation plan for the project entitled "R&D of Key Technologies for Modern Electronic Commerce"—listed as of the highest priority among the SSTC's 15 major tasks—passed the appraisal given by industry specialists a few days ago. This project, considered crucial to the nation's economic development, is being overseen and carried out by SSTC (lead unit), with the assistance of the Ministry of Internal Trade, MEI, and CAS.

China: Software Development Environment State Key Lab Passes Acceptance Tests

96P30158C Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 16 Feb 96 p 2

[Article by reporter Wang Yingde]

[FBIS Summary] The Software Development Environment State Key Laboratory (SKL), preparations for whose construction began 4 years ago, passed State acceptance tests on 18 December last year. This SKL, situated on the campus of Beijing University of Aeronautics and Astronautics (BUAA), has a rich complement of scientific and technical talent, represented by State Council Academic Committee Member Prof. Li Wei [2621 2607]. Over the past few years, this SKL's researchers have undertaken a number of State

863 Program high-tech projects, NSFC-funded projects, Eighth FYP "Climbing Plan" projects, Aeronautical Science Foundation-funded projects, and other national key projects. Among specific results of their work, 29 achievements have been certified, five patents are pending, 22 state and departmental awards have been granted, 327 papers have been published, and 36 books and course texts have been written. Specialties of these researchers include concurrent program design, concurrent language research, and the structured operating semantics method. This SKL has trained 142 master's students, 13 Ph.D.s, and four post-doctoral researchers; the lab is currently training another 78 master's students, 12 doctoral students, and one post-doctoral research fellow, as well as three foreign students. The lab has also actively sought national and international funding and cooperative projects: IBM China has invested 800,000 RMB in the joint construction [with the SKL] of the BUAA-IBM Training Center, the Beijing Municipal Science Commission has invested 3 million RMB for joint construction of the Beijing Municipal New Computer Technologies Key Laboratory, and the U.S. software firm Lotus and the SKL are jointly building the BUAA-Lotus Software Quality Operating Center, specializing in software testing.

China: MEI Releases 1995 Statistics for Electronics Industry, Computer Sector

96P30162A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 4 Mar 96 No 9, p 1

[FBIS Summary] The Ministry of Electronics Industry (MEI) recently released an economic operations report detailing the outstanding achievements realized by the nation's electronics industry—especially the computer sector—in 1995.

According to this report, 1995 was a pivotal year for this industry in the promotion of systems integration, computer aided manufacturing (CAM), hardware manufacturing, and software development, as well as in the conversion of industrial prodution and business services.

According to the "Outline of the Electronics Industry's 10-Year Plan and Eighth 5-Year Plan," the main 1995 economic indicators for this industry were to be as follows:

- gross industrial output value (GIOV) of 130-150 billion RMB [$15.6-18.0 billion]
- per-capita, all-personnel labor productivity of 70,000 RMB [$8,400]
- export volume of $5-7 billion
- an average annual growth rate of 14-17 percent for the 5 years of the Eighth FYP.

These targets were all achieved in 1993 [i.e. the third year of the Eighth FYP]. The actual 1995 figures released in MEI's aforementioned report are as follows:

- the average annual growth rate achieved for the Eighth FYP was 24.2 percent
- GIOV was 245.78 billion RMB [$29.48 billion], a growth of 28 percent from the figure for 1994
- sales revenue was 200.09 billion RMB [$24.00 billion], an increase of 28.2 percent over that for 1994
- per-capita, all-personnel labor productivity (calculated from GIOV) was 120,000 RMB [$14,400]
- electronic-product export value was $16.15 billion, according to Customs statistics
- production of stored-program-controlled (SPC) [telephone] switches totaled 11.69 million lines, an increase of 37 percent over the number for 1994
- production of microcomputers totaled 570,000, a growth of 162 percent over the figure for 1994
- manufacture of integrated circuits (ICs) totaled 470 million, a growth of 112 percent over the number for 1994.

For the computer sector, the report released by MEI lists the following figures for 1995:

- PC gross sales volume was 1.10 million units, an increase of 28 percent over the 860,000 units sold in 1994
- business-PC sales volume was 770,000 units, an increase of 26 percent compared to 1994
- home-PC sales volume was 330,000 units, an increase of 32 percent over the figure for 1994.

MEI estimates the 1996 PC gross sales volume for the China market will reach 1.4 million units. MEI also released the following 1995 figures, compiled from Customs data:

- GIOV of computers exceeded 50 billion RMB [$6 billion], an increase of over 30 percent from the 38.4 billion RMB realized in 1994
- sales volume exceeded 53 billion RMB, another increase of over 30 percent compared to the 40.7 billion RMB achieved in the previous year
- computer-product export value reached $4.5 billion, an increase of more than 60 percent over the $2.8 billion mark reached in 1994.

China: Analysis of EM Scattering Characteristics of Ocean Surface by Complex Astigmatic Waves

96P30153A Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Nov 95 Vol 17 No 6, pp 652-655

[Article by Wang Yueqing [3769 2588 3237] and Wu Guisheng [0702 2710 3932] of the Naval Electronic Engineering College, Nanjing 211800, research supported by grant from the Naval Youth Science Foundation; MS received 24 May 94, revised 14 Dec 94]

[FBIS Summary] Complex astigmatic waves are used to analyze time-varying electromagnetic (EM) scattering characteristics of ocean surface. Numerical results are compared with experimental data, and factors—such as angle of incidence, polarization, and frequency—influencing ocean-surface EM scattering characteristics are investigated.

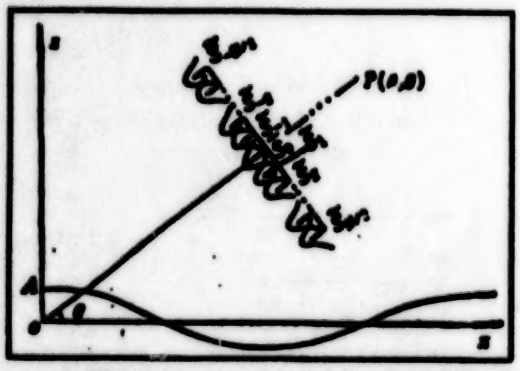

Figure 1. EM Scattering Model for Ocean-Surface Waves

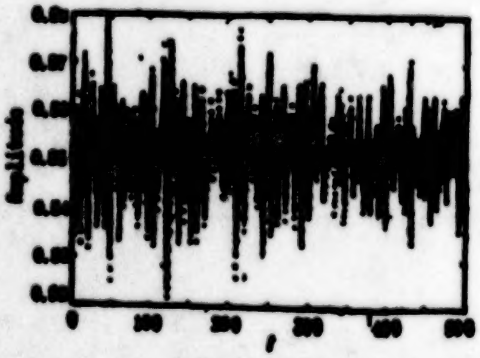

Figure 2. Graph of Ocean-Surface Scattering Field Amplitude vs Time

Four figures, reproduced below, show an EM scattering model for ocean-surface waves, a graph of ocean-surface scattering field amplitude vs time, a graph of the ocean radar cross section (RCS) vs time, and a graph of the ocean RCS vs angle of incidence. For the experimental data, radar operating wavelength λ is 3.0-3.2 cm, angle of incidence $\theta = 15^{\circ}$, typical wave number K_0 for sea waves is 0.09 rad/m, undulation frequency $F_0 = 0.15$ Hz, and wave amplitude A = 1.57-1.80 m. There are no tables.

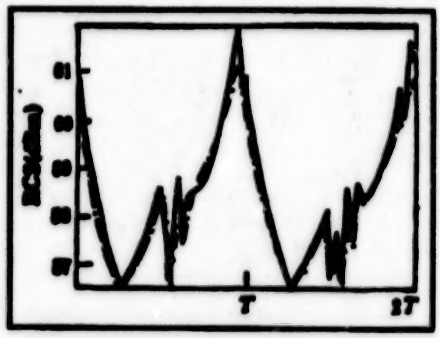

Figure 3. Ocean RCS vs Time

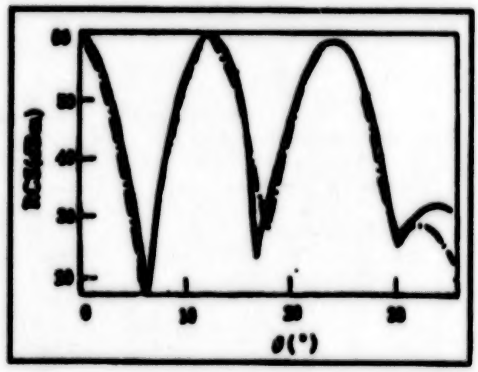

Figure 4. Ocean RCS vs Angle of Incidence

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China: Research on Application of Wigner-Ville Distribution in SAR

96P30153B Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF THE UNIV. OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA (UESTC)] in Chinese Dec 95 Vol 24 No 6, pp 584-589

[Article by Zhao Zhiqin [6932 1807 2953] and Huang Shunji [7806 7311 0679] of the Dept. of Electronic Engineering, UESTC, Chengdu 610054, research supported by grant from SSTC's 863 High-Tech Program; MS received 2 Apr 95, revised 3 May 95]

[FBIS Summary] The synthetic aperture radar (SAR) imaging model and the Wigner-Ville Distribution (WVD) are analyzed. The latter is applied to obtain the Doppler SAR parameters of moving targets. The properties of the WVD cross terms are discussed. Time averaging is used to suppress these cross terms for multiple moving targets. Simulation results validate the effectiveness of this time-averaging method and the feasibility of using WVD to acquire the moving-target parameters in the SAR system.

Four figures, reproduced below, show the geometric relationship between the aircraft carrying the SAR and point A, results of the computer simulation of the WVD, a schematic of the SAR imaging, and the spectral plots of $x[n]$ and $y[n]$, respectively. In the simulations, the number of sampling points is 256, PRF = 1000 Hz, Doppler frequency f_d is either 100 Hz or 200 Hz, and Doppler frequency rate of change f_{dr} is 200 Hz/s or 400 Hz/s. There are no tables.

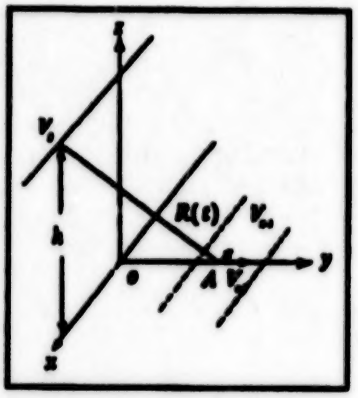

Figure 1. Geometric Relationship Between Aircraft and Point A

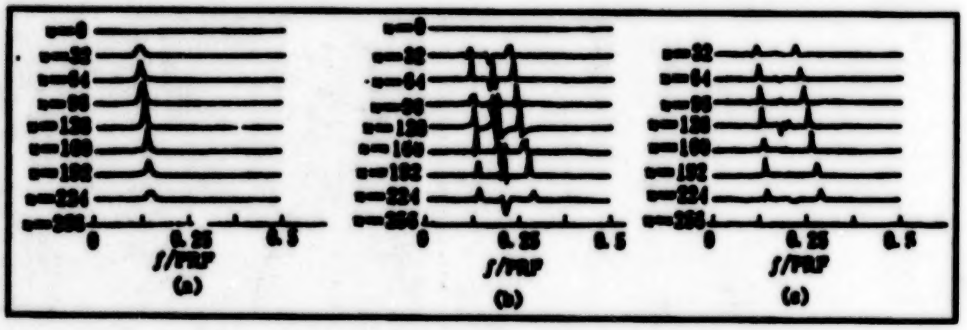

Figure 2. Results of Computer Simulation of WVD

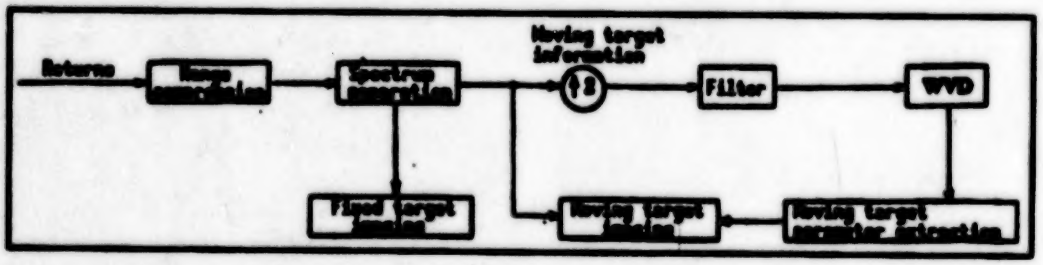

Figure 3. Schematic of SAR Imaging

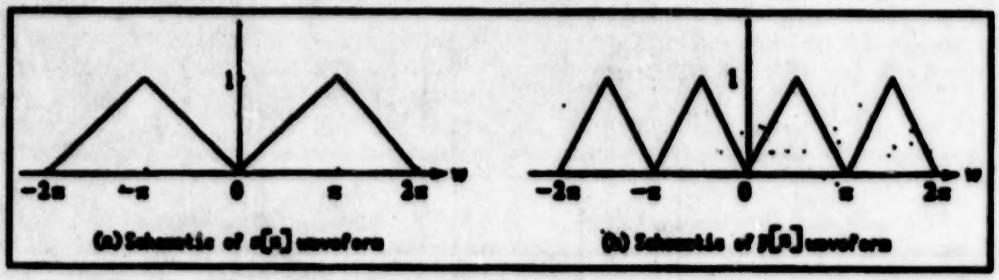

Figure 4. Spectral Plots of $x[n]$ and $y[n]$

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China: Real-Time, High-Resolution Imaging in Squint-Mode SAR

96P30153C Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF THE UNIV. OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA (UESTC)] in Chinese Dec 95 Vol 24 No 6, pp 590-595

[Article by Dai Shengli [0108 0524 0448] and Huang Shunji [7806 7311 0679] of the Department of Electronic Engineering, UESTC, Chengdu 610054, research supported by grants from SSTC's 863 High-Tech Program and the State Education Commission's Ph.D.-Focus Foundation; MS received 9 May 95, revised 26 May 95]

[FBIS Summary] In conventional SAR, the radar is pointed in a direction perpendicular to the velocity vector of the radar platform, i.e., in the side-looking direction. Squint-mode SAR, also called squint side-looking strip-imaging-mode SAR, has important military application advantages compared to conventional side-looking SAR. For example, squint-mode SAR, with its variable radar-beam squint angle, can acquire multiple imagings of the target terrain with only one pass of the radar platform over the target. This paper presents a new method for real-time, high-resolution squint-mode SAR imaging. This new pre-processing method eliminates the inherent azimuth-range coupling in squint-mode SAR imaging and reduces the influence of azimuth higher-order phase on azimuth resolution.

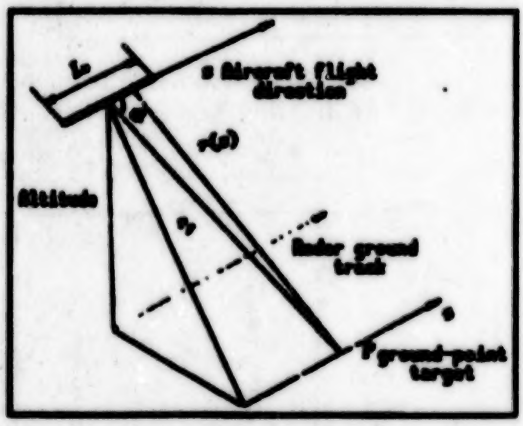

Figure 1. Geometrical Relationships in Squint-Mode SAR Imaging

Five figures, reproduced below, show the geometric relationships in squint-mode SAR imaging, the point matrix for SAR transmitted pulse position, the geometric relationship between the squint-mode SAR imaging region and the synthetic aperture, squint-mode SAR imaging of a two-point target for squint-angle complementary angle $\eta_c = 90°$, and squint-mode SAR imaging of a two-point target for $\eta_c = 45°$. Other parameters are as follows: range $r_p = 200$ km, phase difference Δr be-

tween the two target points along the slant range is 1 km, point separation Δx is also 1 km, and imaging resolution (Figures 4 and 5) is 2 m x 2 m. There are no tables.

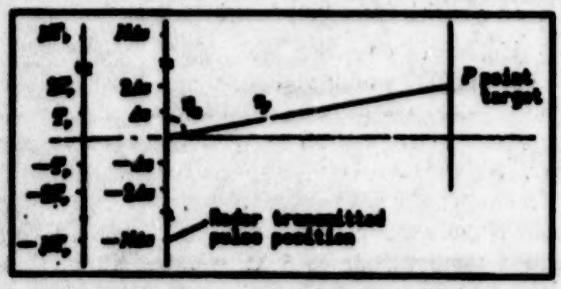

Figure 2. Point Matrix for SAR Transmitted Pulse Position

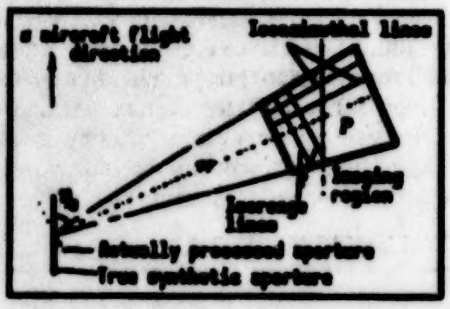

Figure 3. Geometrical Relationship Between Squint-Mode SAR Imaging Region and Synthetic Aperture

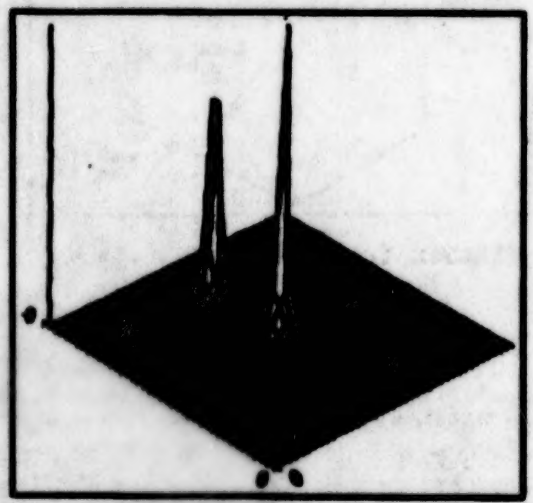

Figure 4. Squint-Mode SAR Imaging of Two-Point Target ($\eta_c = 90°$)

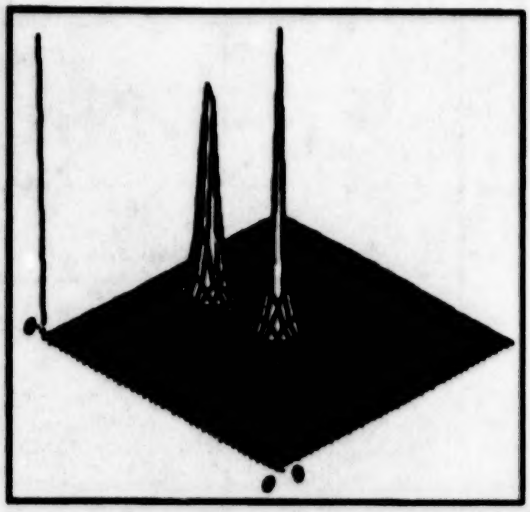

Figure 5. Squint-Mode SAR Imaging of Two-Point Target ($\eta_c = 45°$)

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China: IEEV Method for Estimating Directional Spectra of Sea Waves

96P30153D Qingdao QINGDAO HAIYANG DAXUE XUEBAO [JOURNAL OF OCEAN UNIV. OF QINGDAO] in Chinese Jan 96 Vol 26 No 1, pp 1-7

[Article by Guan Changlong [4619 7022 7893] of the Institute of Physical Oceanography, OUQ, research (project #19332010) supported by grant from NSFC; MS received 5 Jul 95, revised 5 Nov 95]

[FBIS Summary] The iterative procedure (IMLM) proposed by Pawka (1983) for improving the maximum likelihood method (MLM) for estimating the directional spectra of sea waves is applied to the extended eigenvector method (EEV) derived by Guan et al. (1995) as an iterative EEV (IEEV) algorithm. The IEEV is verified and compared with the EEV by numerical simulations in the present paper. In these numerical simulations, Longuet-Higgins directional spreading functions are employed as input and the existence of noise background in the input is considered. Three types of wave-probe array—pitch/roll buoy, star array, and CERC [?Coastal Engineering Research Council] array—are adopted. The simulation results show that the IEEV is superior to the EEV and is especially appropriate for sea waves with high background noise and narrow angular spread. The IEEV and EEV are applied to the analyses of field observation data obtained (at an oil platform) with a four-probe array for estimating the directional spectra of sea waves. These spectra are reasonable and reliable.

Six figures, reproduced below, show a comparison of EEV and IEEV estimates of the directional spreading function $E(\theta)$ with the input (a known spectrum) for the case of the pitch/roll buoy; variation of weighted average error (WAE) with noise-to-signal ratio (NSR) for the input, the EEV estimate, and the IEEV estimate [inadvertently omitted] and for all three types of wave-probe array; variation of WAE with half-value angular width $\Delta\theta$ for the input, the EEV estimate, and the IEEV estimate [inadvertently omitted] and for all three types of array; EEV and IEEV estimates and the input of the bimodally directional spreading function; variation of WAE with $\Delta\phi$ (the angular separation between the two main wave directions) for the input, EEV estimate, and IEEV estimate [inadvertently omitted]; and directional spectra (four different values of angular frequency ω) estimated from the field data of the instrument array described in Figure 8 of reference [5].

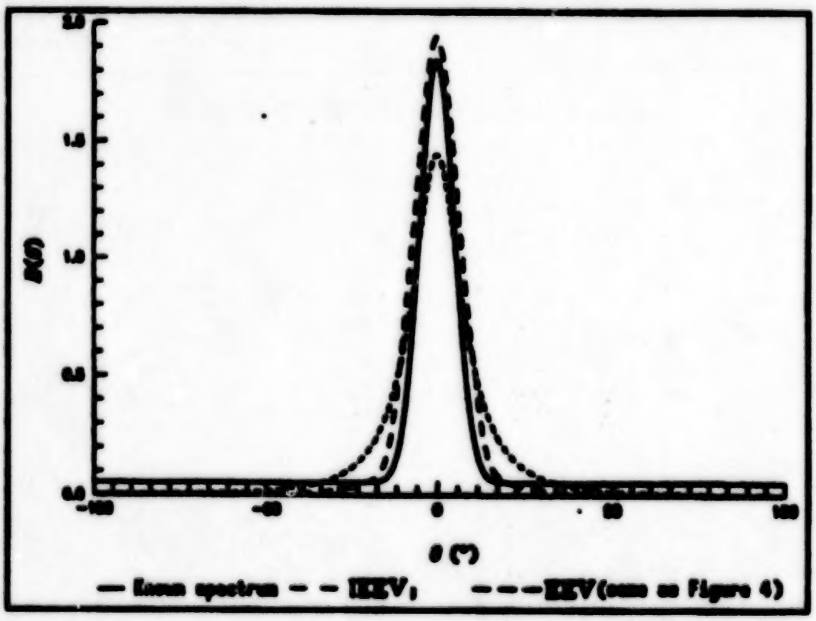

Figure 1. Estimates and Input of Directional Spreading Function (Case of buoy)

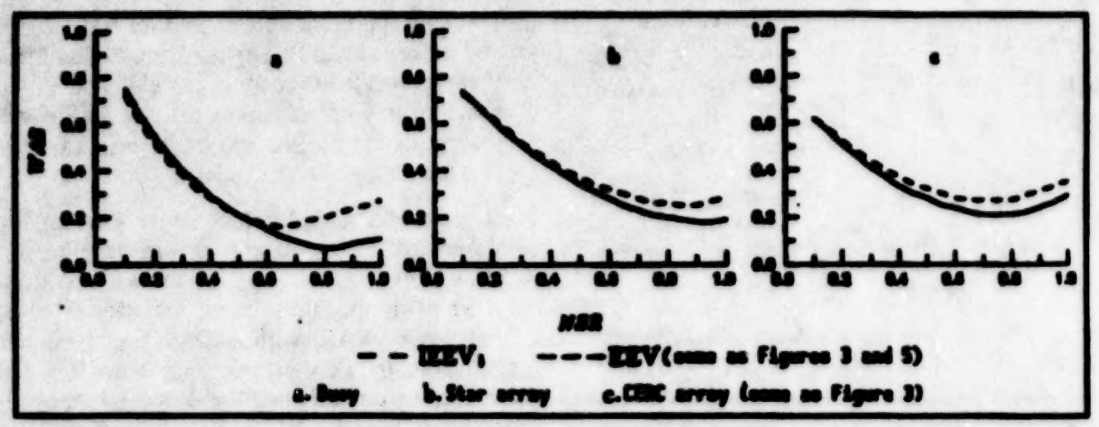

Figure 2. Variation of WAE With NSR

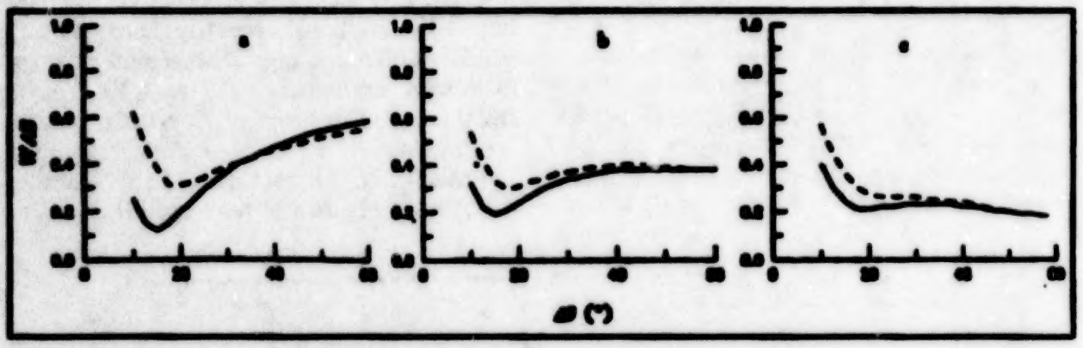

Figure 3. Variation of WAE With $\Delta\theta$

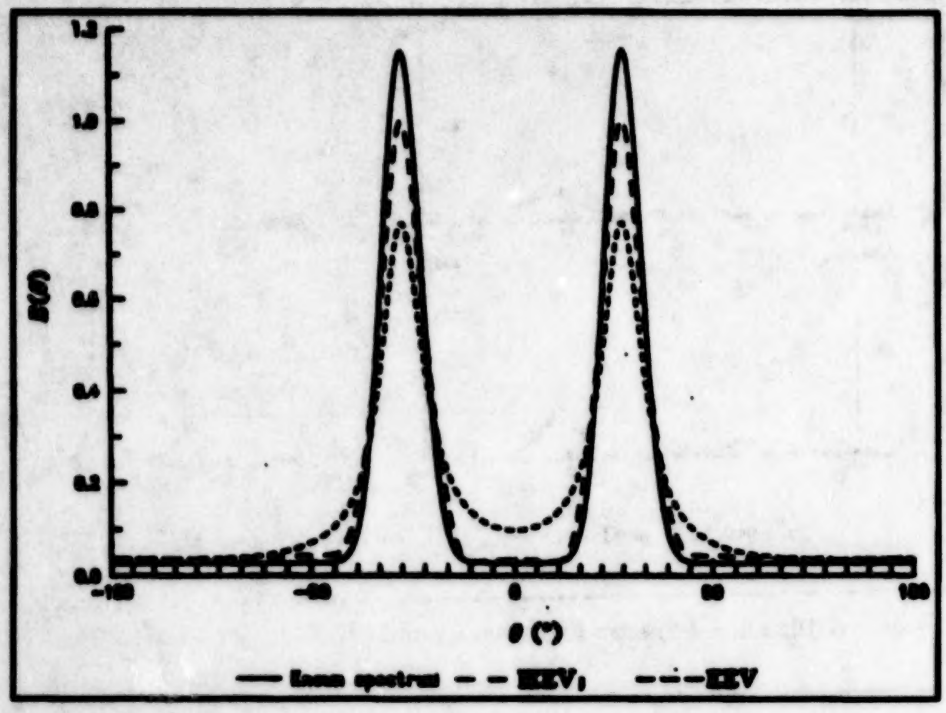

Figure 4. Estimates and Input of Bimodally Directional Spreading Function

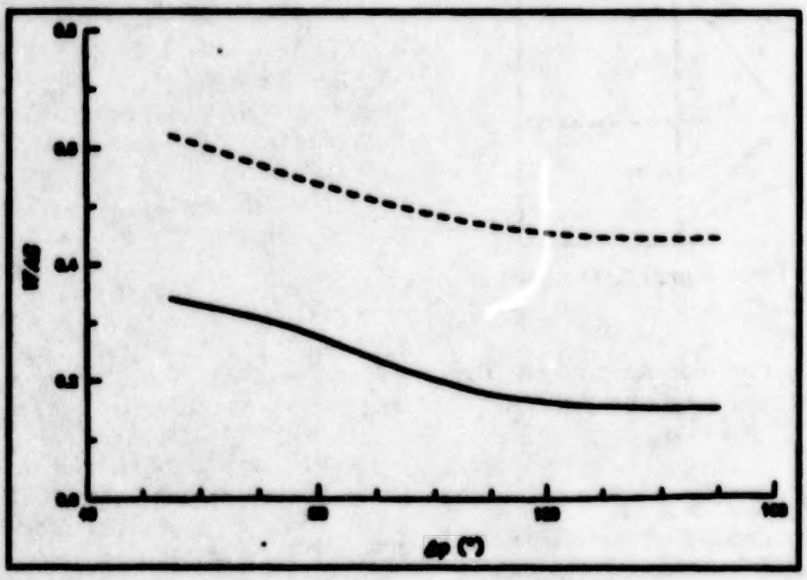

Figure 5. Variation of WAE With $\Delta\phi$

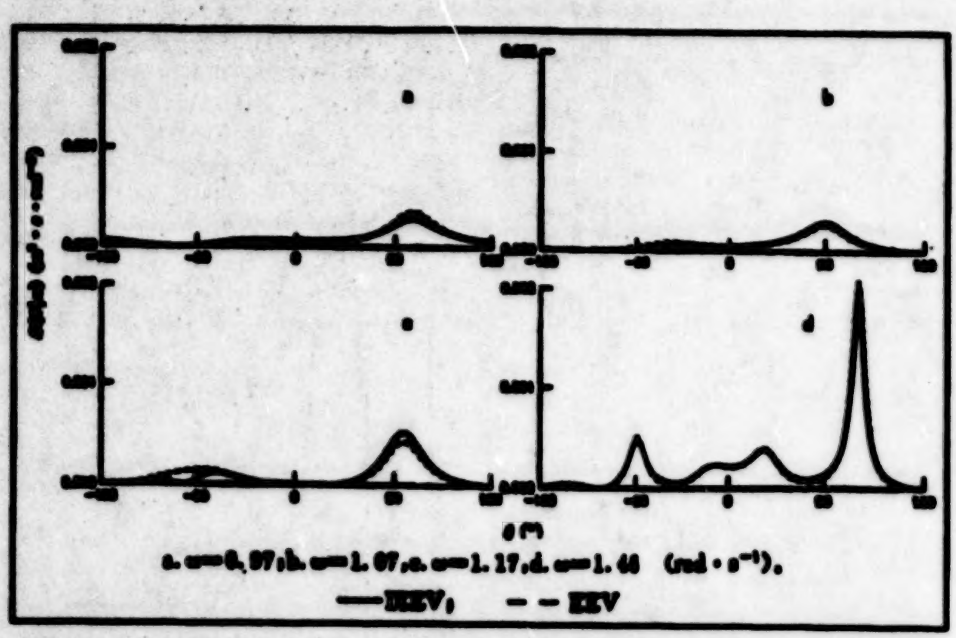

Figure 6. Directional Spectra Estimated From Field Data of Instrument Array

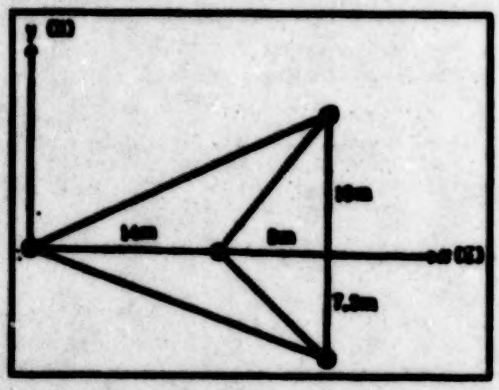

Figure 8. Schematic of Instrument Array Used in Figure 6.

Circles represent CBS vertical-line wave gauges. The x direction is to the east and the y direction is north. (Reproduced from ref. [5], p. 245).]

The pitch/roll buoy (Figure 1) is a single-point measurement device for two mutually vertical components of the wave surface: height and slope; a frequency of 0.1 Hz is assumed. The star array is a four-probe device; coordinates of the four probes are, respectively, as follows: $r_1 = 0$, $\theta_1 = 0$, $r_2 = r_3 = r_4 = \alpha$, $\theta_2 = 0$, $\theta_3 = 2\pi/3$, $\theta_4 = -2\pi/3$. The CERC array is a five-probe device, with the following respective probe coordinates: $r_1 = 0, \theta_1 = 0$, $r_2 = r_3 = r_4 = r_5 = \alpha$, $\theta_2 = \pi/5$, $\theta_3 = 3\pi/5$, $\theta_4 = -\pi/5$, $\theta_5 = -3\pi/5$. For these two arrays, α is defined as the minimum spacing between probes, and the ratio of wavelength L to α is assumed to be 5. In Figure 1, NSR = 0.5 and $\Delta\theta = 20°$. In Figure 2a, b, and c, $\Delta\theta = 50°$, 30°, and 20°, respectively. In Figure 3a, b, and c, NSR is 0.2, 0.5, and 0.75, respectively. In Figure 4, the known-spectrum parameters are $\Delta\theta = 20°$, NSR = 0.2, and $\Delta\phi = 100°$. In Figure 5, NSR = 0.2 and $\Delta\theta = 20°$. The instrument array in Figure 6, whose configuration and dimensions are detailed in Figure 8 [borrowed from reference [5], consists of five CBS-type [compact buoy system] vertical-line wave gauges; effective wave height H = 0.42 m and effective period T = 3.22 s, just as in ref. [5]. There are no tables.

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China: Use of Artificial Neural Network To Divide Magnetic Anomaly Field of South China Sea

96P30153E Qingdao QINGDAO HAIYANG DAXUE XUEBAO [JOURNAL OF OCEAN UNIV. OF QINGDAO] in Chinese Jan 96
Vol 26 No 1, pp 83-90

[Article by Jiang Xiaodian [1203 2400 0368] of the College of Marine Geosciences, OUQ; MS received 15 May 95, revised 22 Jul 95]

[FBIS Summary] A method of quantitative calculation is presented for processing magnetic measurement data to divide a magnetic anomaly field via an artificial neural network (ANN). This method is successfully applied to the South China Sea, which is divided into 12 characteristic regions. Each region under study is divided into statistical elements with six appropriately selected control variables. Standard models are selected and used to train the back-propagation (B-P) ANN. The network that has demonstrated learning is used to recognize and analyze the entire magnetic anomaly field of each region under study.

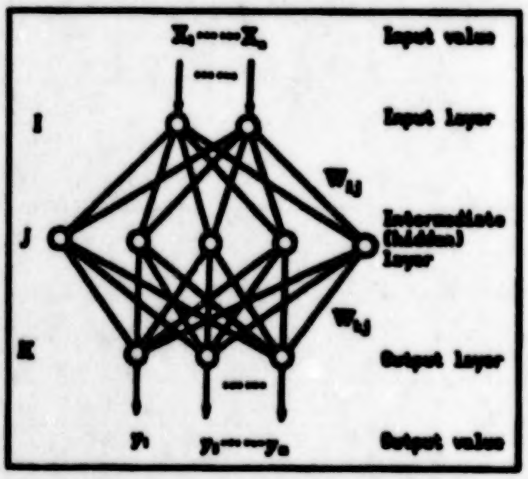

Figure 1. Schematic of Network Structure

Five figures, reproduced below, show a schematic of the ANN structure, a graph of F-PFS vs C [expansions not given] for dividing the magnetic anomaly field, a map of the division of the magnetic anomaly field of the South China Sea into 12 regions, a map of this division as done by the ANN, and a map of this division by the Fuzzy ISODATA Method (ref. [5]). The one table, reproduced below, lists model data for the 12 regions of magnetic anomaly fields. Intensities of the magnetic anomalies vary from about 30 nT to 150 or even 200 nT, depending on the region.

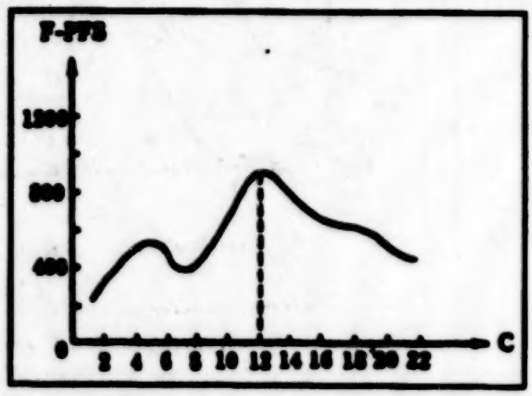

Figure 2. F-PFS vs C Curve for Dividing Magnetic Anomaly Field

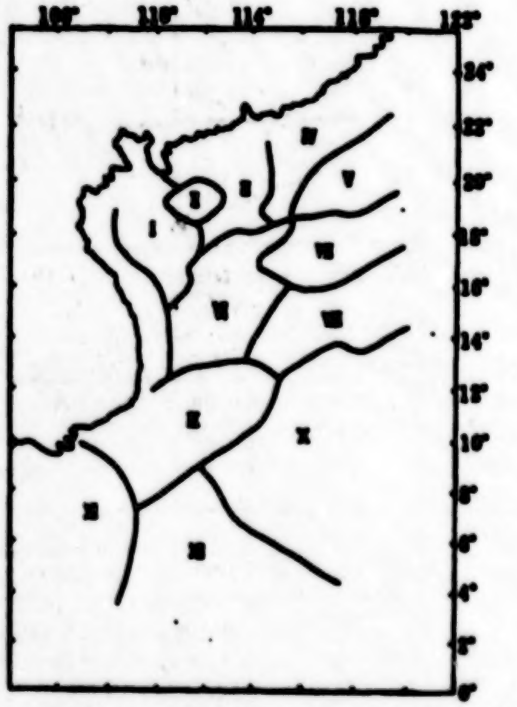

Figure 3. Division of the Magnetic Anomaly Field in the South China Sea

Figure 4. Division of the Magnetic Anomaly Field in the South China Sea by ANN

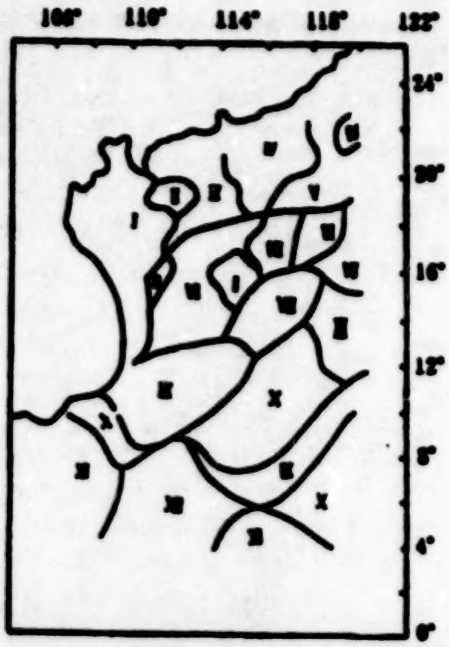

Figure 5. Division of the Magnetic Anomaly Field in the South China Sea by Fuzzy ISODATA

Table 1. Model Data of 12 Regions of Magnetic Anomaly Fields

No.	Intensity of ΔT anomaly (nT)	Horizontal gradient of ΔT	ΔT intensity of upward continuation 20 km	Foundation susceptibility	Gradient of magnetic anomaly or not	Positive and negative anomaly appear together or not	Wave magnetic anomaly on EW direction or not	Wave magnetic anomaly on NE direction or not
1	-100	-100	-12	0	1	0	0	0
2	50	100	3.5	50	1	0	0	0
3	0	-50	35	150	0	0	0	0
4	0	50	18.5	75	1	1	0	0
5	-50	-100	-9	0	0	0	1	0
6	-150	50	0	-25	1	1	0	0
7	50	0	15	25	1	1	0	0
8	0	0	-20	50	0	1	0	1
9	100	50	-10	50	1	0	0	0
10	100	0	-10	0	0	0	0	0
11	150	100	-15	-350	1	0	0	0
12	-100	50	0	-400	1	1	0	0

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China: Ship-Radiated Noise Analysis With Higher-Order Spectrum, Its Signature

96P30154A Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Jan 96
Vol 21 No 1, pp 29-39

[Article by Wu Guoqing [0702 0948 3237] of the CAS Institute of Acoustics, Beijing 100080 and the National Lab. of Pattern Recognition, CAS, Beijing 100080; Ren Rui [0117 6904] and Chen Yaoming [7115 5069 2494] of the CAS Institute of Acoustics, and Li Xungao [2621 6064 6138] of the Naval Submarine Institute, Qingdao 266071, research supported by grant from NSFC; MS received 8 Apr 94]

[FBIS Summary] Higher-order statistics are used to extract the phase information in the periodical-modulation waveforms of ship-radiated noise. The results from an analysis of actual data are compared with those of a computer simulation and a phase-extraction method is presented. The periodical-modulation waveform is reconstructed from its bispectrum phase and amplitude information, and the reconstructed signal is called the ship's "signature." The cross-correlation functions between the signatures of three ships and their real-modulation waveforms are given. It is clear that the normalized correlations between the signatures and real-modulation waveforms of the same ship are much higher than those between different ships. Finally, one ship-radiated noise characteristic with broad application prospects is discovered: the modulation waveforms in different frequency bands for this noise are very much alike.

The six figures and three tables are reproduced below. In Figure 1, the bandpass filter has a center frequency of 900 Hz and a bandwidth of 750 Hz. In Figure 2, one can clearly see the regular δ line; the frequency position of the fundamental δ line reflects this ship's propeller rotational speed (i.e., the 6.125-Hz fundamental represents a propeller rotational speed of 386 rpm).

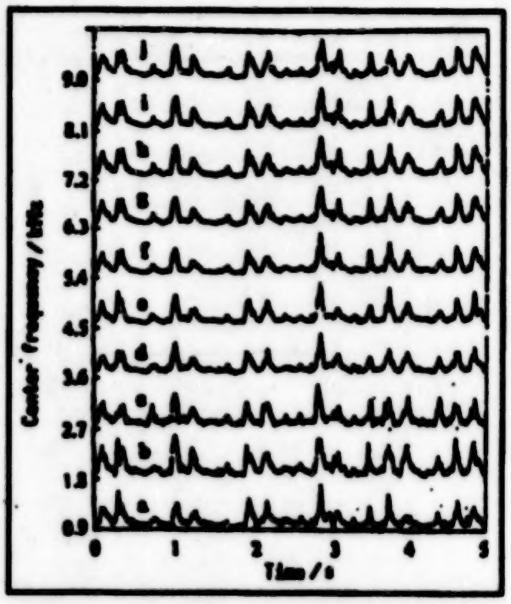

Figure 1. Envelope Waveform of Cargo Ship-Radiated Noise After Subband Grouping

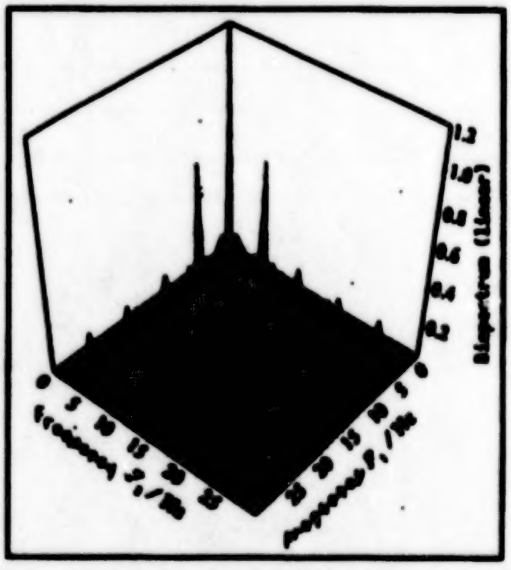

Figure 2. Bispectrum Amplitude Spectrum of (Pa-si-hao) [?Passau] Cargo Ship

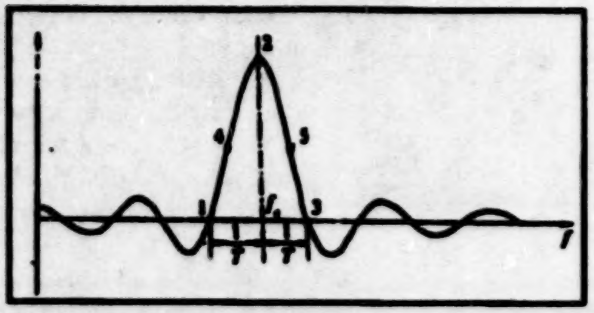

Figure 3. Schematic of Error Introduced by Frequency Discretization

Table 1. Mean, Standard Deviation (SD) of Bispectrum Phase Estimates of Periodic Signals with Different SNRs

	Harmonic-group phase value	ψ_{11}	ψ_{12}	ψ_{13}	ψ_{14}	ψ_{22}	ψ_{23}	ψ_{24}	ψ_{33}	ψ_{34}
	Standard value of phase	6.4°	1.8°	-9.4°	None	-14°	None	None	None	None
SNR = 36.6 dB	Mean	8.9°	1.6°	-6.6°	16°	-13.9°	18.7°	6.32°	-1.8°	-9.2°
	SD	5.4°	3°	4.4°	104°	5.6°	101°	113.5°	114°	105°
SNR = 10.7 dB	Mean	9.4°	-0.7°	-5.3°	42°	-15.4°	63.4°	24.3°	19.7°	-10.4°
	SD	7.7°	4.9°	12°	107°	11.1°	89.4°	105°	106.6°	107.3°
SNR = 2.7 dB	Mean	11,1°	-8.6°	5.1°	3.5°	-14.0°	51.6°	48°	-9.9°	-8.2°
	SD	23.7°	23.4°	50.9°	103°	48.7°	103.6°	93.2°	98°	103°

Table 2. Mean, SD of Bispectrum Phase Estimates for Periodical-Modulation Signal from (Pa-si-hao) Cargo Ship

Harmonic-group phase value	ψ_{11}	ψ_{12}	ψ_{13}	ψ_{14}	ψ_{22}	ψ_{23}	ψ_{24}	ψ_{33}	ψ_{34}
Mean	6.4°	1.8°	-9.4°	18.1°	-14°	18.4°	12.8°	13.3°	13.8°
SD	7.7°	22.8°	39.5°	99°	34.5°	92.6°	105°	87.9°	84.3°

Table 3. Cross-Correlation Factors (Mean Values) Between This Ship and Different Ships

		Actual signals		
		Pa-si-hao	Daqing 61	U.S. cargo ship
Signature	Pa-si-hao	0.82	0.39	0.21
	Daqing 61	0.39	0.80	0.18
	U.S. cargo ship	0.12	0.13	0.78

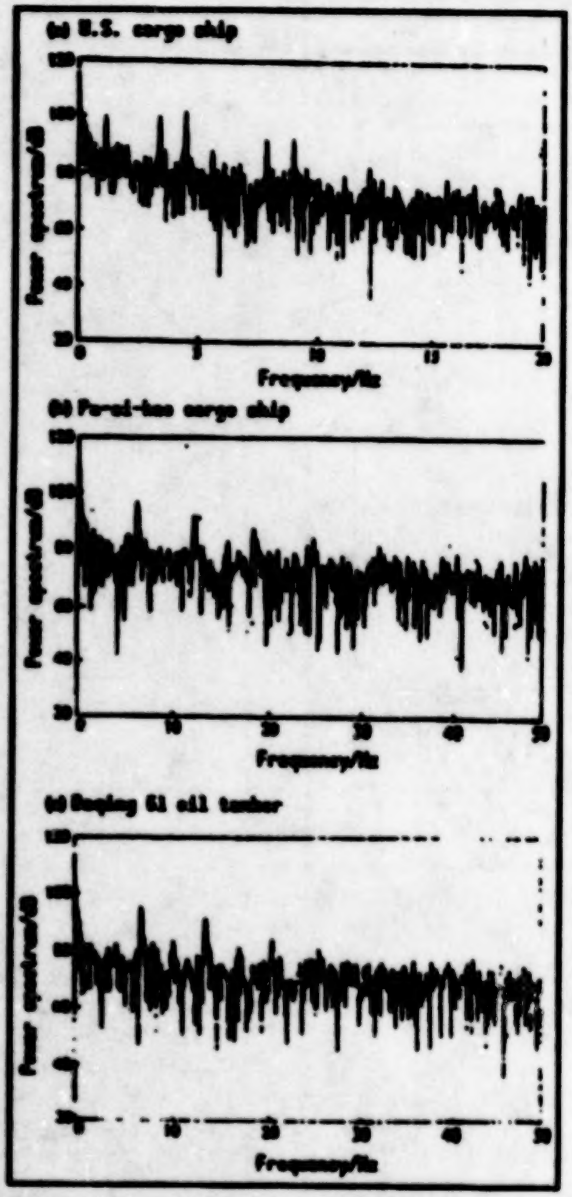

Figure 4. Power Spectra of Amplitude-Modulation (AM) Signal of Three Ships

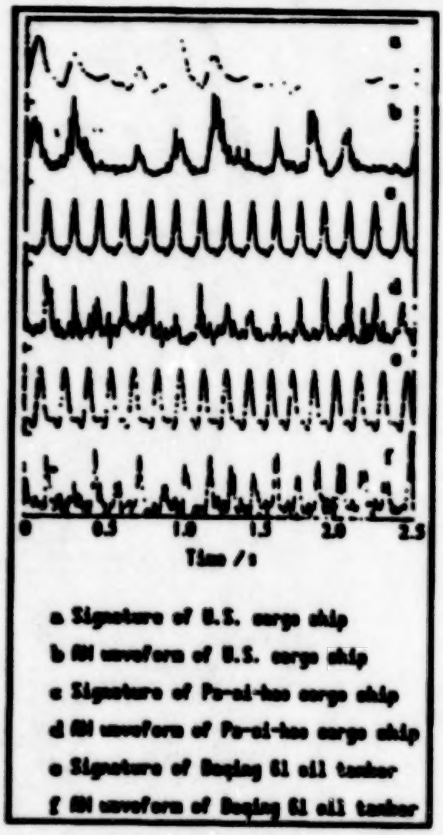

Figure 5. AM Waveforms of Three Ships and Their Signatures (i.e., Reconstructed Periodical AM Waveforms)

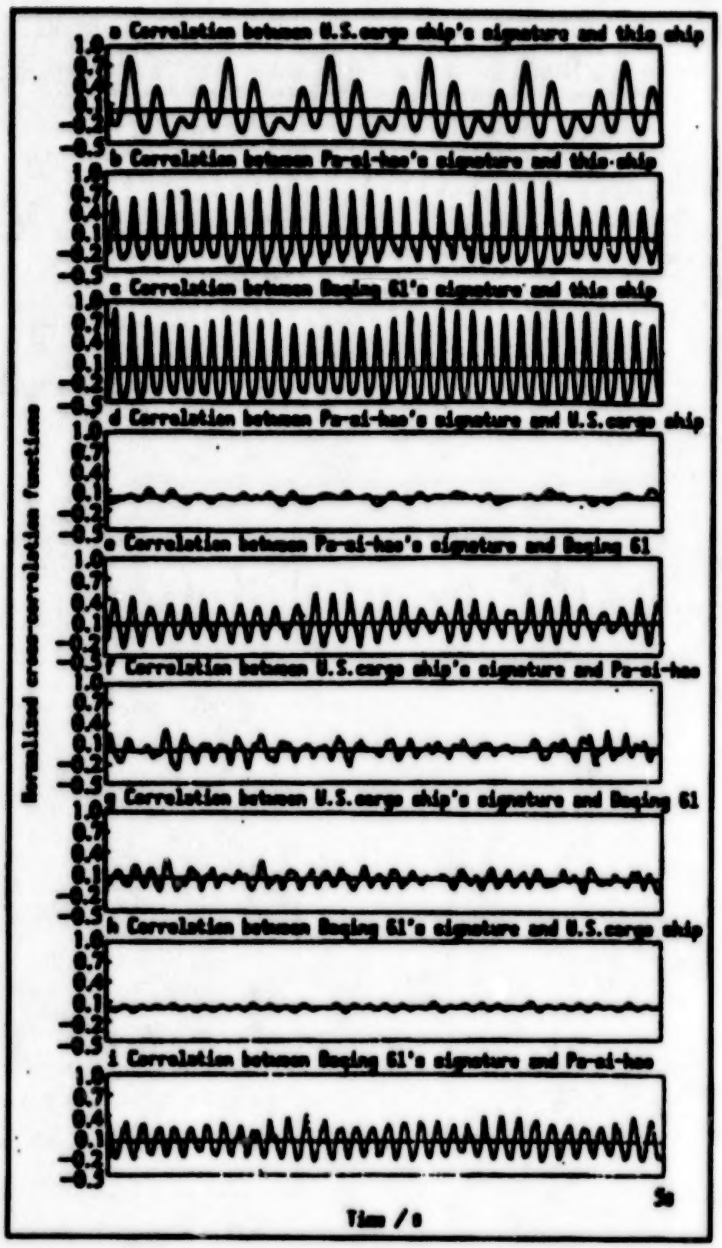

Figure 6. Cross-Correlation Curves Between Signatures and Actual AM Signals

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China: Pattern Recognition of Acoustic Sea-Bed Profiling Records (Part 1: Dynamic Reasoning Expert System)

96P30154B Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Jan 96
Vol 21 No 1, pp 40-48

[Article by Zhang Shuying [1728 0647 5391] and Lin Yijun [2651 0076 0193] of the CAS Shanghai Acoustics Laboratory, Shanghai 200032, research project #90BDO5101 supported by a grant from the Shanghai Municipal Natural Sciences Foundation; MS received 1 Mar 95]

[FBIS Summary] A computer-based pattern recognition system has been developed for geological interpretation of Acoustic Sea-bed Profiling Records (ASPRs). Based on practical experience accumulated by specialists and incorporated since 1990 into a knowledge base, the main pattern characteristics of ASPRs corresponding to typical geological categories of marine sediment layers in the East China Sea are jointly expressed in nine aspects. A corresponding dynamic reasoning expert system has been designed. This system starts from an initial premise characteristic of the ASPR being interpreted and follows a defined "context tree" including 18 reasoning rules (given in the appendix but not reproduced here). The expert system successively collects the next premise characteristic and takes the next reasoning step until the final conclusion (i.e., to which geological category the sediment layer belongs) is reached. Meanwhile, for quantitative estimation of the correctness of the final conclusion, the so-called "certainty factor" is calculated.

Four figures, reproduced below, show a schematic of the pattern recognition system, the search tree for the expert system's determination of a layer, a recording of the acoustical layer cross section of Biandansha in the Chang Jiang (i.e,. Yangtze River) delta, and the expert system's interpretation of the Biandansha data, respectively. The one table, reproduced below, lists the layer categories and corresponding pattern characteristics (image features). The nine pattern-characteristic aspects are as follows:

- X_1: indicates a shallow layer beneath the interface line
- X_2: indicates a continuous shallow layer beneath the interface line
- X_3: indicates prominent rises and declines beneath the interface line
- X_4: indicates regular earth fluctuations beneath the interface line
- X_5: indicates a nonuniform interface line assuming a concave or convex shape
- X_6: indicates a relatively coarse interface line, with many gray levels
- X_7: indicates thin streaks between the layers
- X_8: indicates that the lines between the layers are densely crowded together, fine, and crisscrossing
- X_9: indicates that the underside of the interface has a white belt

The inverses of these nine aspects are labeled X[bar]$_1$ through X[bar]$_9$, respectively, in Table 1; for example, X[bar]$_1$ indicates the lack of a shallow layer beneath the interface line.

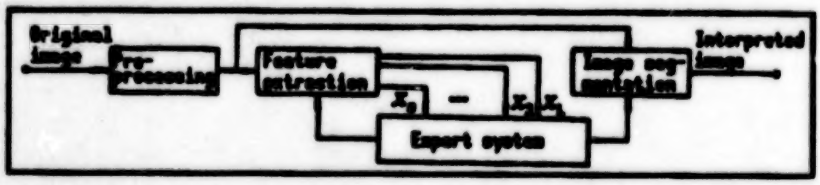

Figure 1. Schematic of Pattern Recognition System for Acoustical Layer Profiling Records

Table 1. Layer Categories and Corresponding Pattern Characteristics

Bedrock	$\overline{X}_1 \rightarrow X_2 \rightarrow X_6 + \overline{X}_9$
Old clay	$\overline{X}_1 \rightarrow X_2 \rightarrow X_6 + X_9$
Large sand layer	$\overline{X}_1 \rightarrow \overline{X}_2 \rightarrow X_6 + \overline{X}_9$
Fine sandy layer with dunes	$\overline{X}_1 \rightarrow X_2 \rightarrow X_6 + \overline{X}_9$
Earth/sand crisscross layer	$X_1 \rightarrow \overline{X}_2 \rightarrow X_6 + X_9$
Gravel layer	$\overline{X}_1 \rightarrow \overline{X}_2 \rightarrow X_6 + X_9$
Slurry	$X_1 \rightarrow X_2 \rightarrow \overline{X}_6 + \overline{X}_7$
Drifting mud	$X_1 \rightarrow X_2 \rightarrow \overline{X}_6 + X_7$
Semiclay	$X_1 \rightarrow X_2 \rightarrow X_6 + \overline{X}_9$
Thin silt layer	$X_1 \rightarrow \overline{X}_2 \rightarrow X_6 + \overline{X}_9$
Thin silt wave	$X_1 \rightarrow \overline{X}_2 \rightarrow X_6 + \overline{X}_9$
Foreign matter	$\overline{X}_1 \rightarrow X_2 \rightarrow X_6 + X_9$

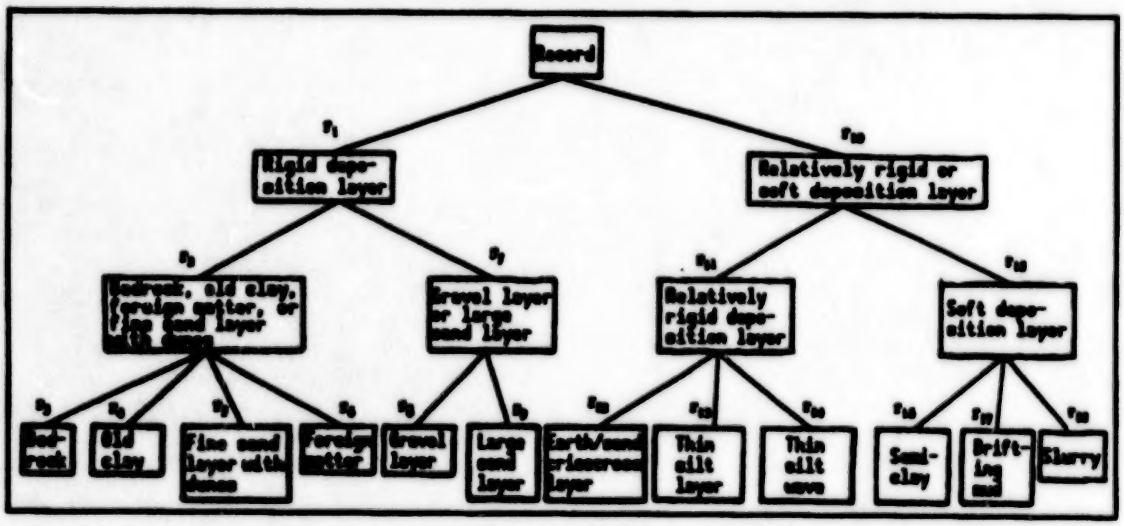

Figure 2. Search Tree for Expert System's Determination of a Layer

Figure 3. Acoustical Layer Cross-Section Record of Biandansha in Chang Jiang Delta

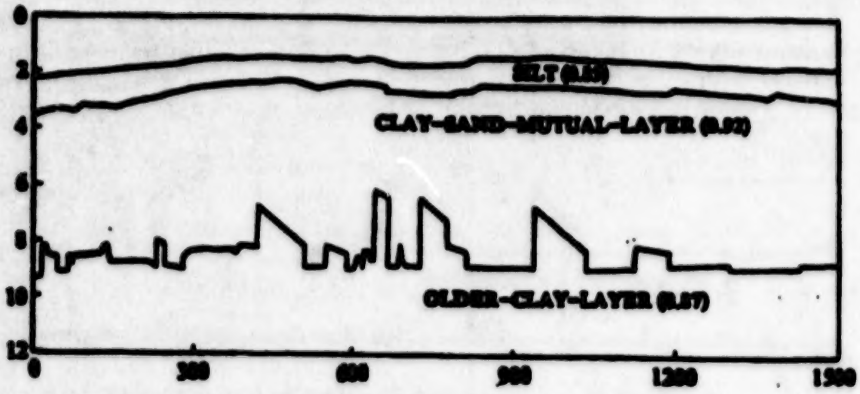

Figure 4. Expert System's Interpretation of Figure 3

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China: Recent Development in Reliability Research for Submarine Pressure Hull

963A0011A Wuhan HAIJUN GONGCHENG XUEYUAN XUEBAO [JOURNAL OF THE NAVAL ACADEMY OF ENGINEERING] in Chinese Sep 95 No 3, pp 59-65

[Article by Huang Jiaqiang, Feng Wenshan, et al. of the Department of Ship Building Engineering, the Naval Academy of Engineering, Wuhan: "Recent Development in Reliability Research for Submarine Pressure Hull"; MS received 27 Oct 94]

[FBIS Summary] This paper addresses the results of the reliability research on the structure of a submarine pressure hull, including basic variables and their effects on reliability, reliability computing methods, reliability design and analysis and the determination of safety standards. Future development for the reliability of submarine structure is proposed.

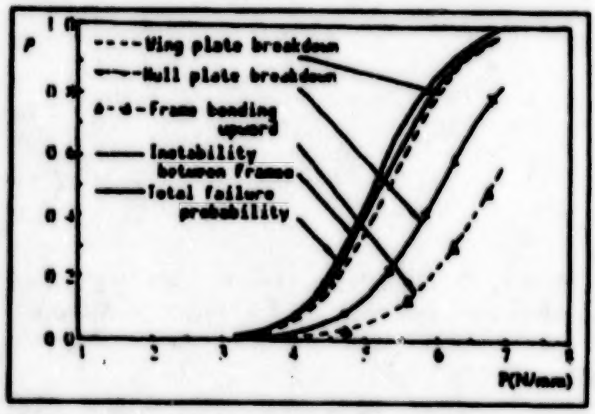

Fig. 1. Curves for the probability of failures under different types of breakdown on the submarine pressure hull

Faulkner's (of Britain) theory is widely used and applied in the paper in reliability research on the structure of a submarine pressure hull. The reliability computation is based on Faulkner's theory that the total probability of failure is the sum of probability of failure under different modes of breakdown, including wing plate breakdown, hull plate breakdown, frame bending, and the instability between the frames. There are two figures shown in the paper: figure 1 shows the curves for

the probability of failures under different types of breakdown on the submarine pressure hull; and figure 2 shows the fuzzy definition of breakdown level. There is no table. References: 18 English, 7 Chinese.

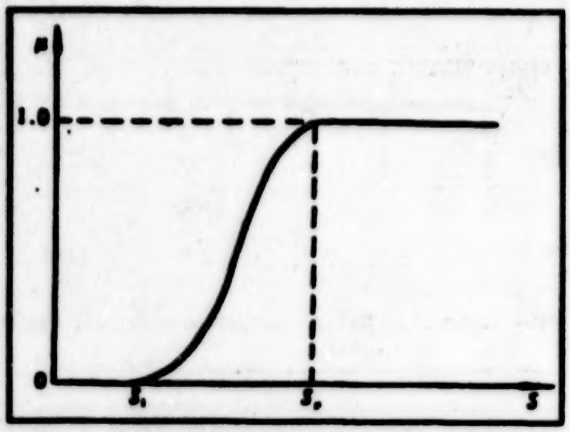

Fig. 2. Fuzzy definition of breakdown level

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China: Development of New Power Batteries, Propelling Motors for Torpedoes

963A0011B Wuhan HAIJUN GONGCHENG XUEYUAN XUEBAO [JOURNAL OF THE NAVAL ACADEMY OF ENGINEERING] in Chinese Sep 95 No 3, pp 66-74

[Article by Wang Shuzong of the Naval Weapons Engineering Department, Naval Academy of Engineering: "Development of New Power Batteries, Propelling Motors for Torpedoes"; MS received 13 Dec 94]

[FBIS Summary] This article addresses the development of new power batteries and propelling generators for torpedoes in major naval nations, and it also analyzes the problems related to the development. The article mainly focuses on two types of battery, the aluminum/silver oxide battery and the Li/$SOCl_2$ battery; in addition, other types of power batteries discussed include the lithium/silver oxide battery, lithium alloy thermal battery, and the Ca/$SOCl_2$ battery. For enhancing the performance of the propelling motors for torpedoes, the uses of permanent-magnet generators, dc generators without commutators, ac generators, and high-temperature and high-strength materials are discussed. Lastly, superconducting generators and Magneto-Hydro-Dynamic (MHD) propelling technologies for torpedo applications are presented.

There are nine figures shown in the article: figure 1 shows a schematic of the operating principle of the battery; figure 2 shows the discharging curve of a typical aluminum/silver oxide battery; figure 3 shows the discharge characteristics of a 13kW lithium experimental battery; figure 4 shows a schematic of a lithium battery for large-scale torpedoes; figure 5 shows a block diagram of the auxiliary system of the lithium/silver oxide battery; figure 6 shows a schematic of a single-pole dc generator with superconducting magnetic coil; figure 7 shows a schematic of a double-pole generator with superconducting magnetic coil; figure 8 shows the relationship between the MHD magnetic flux intensity and the travelling speed of the torpedo; and figure 9 shows a schematic of the MHD propeller. There are no tables presented in the article. References: 2 Chinese.

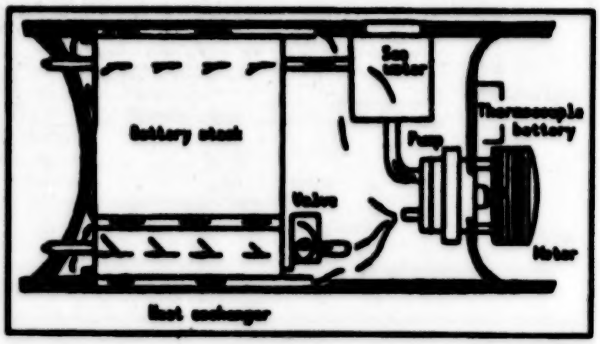

Fig. 1. Schematic of the operating principle of the battery

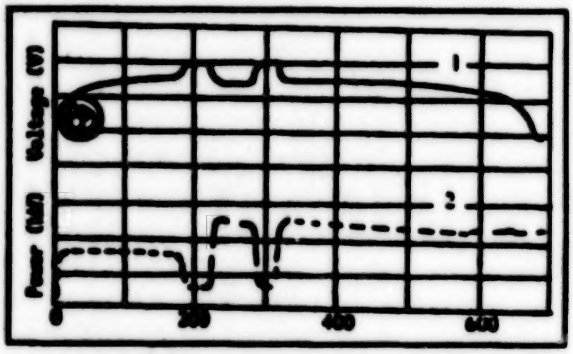

Fig. 2. Schematic of the discharging curve of a typical aluminum/silver oxide battery

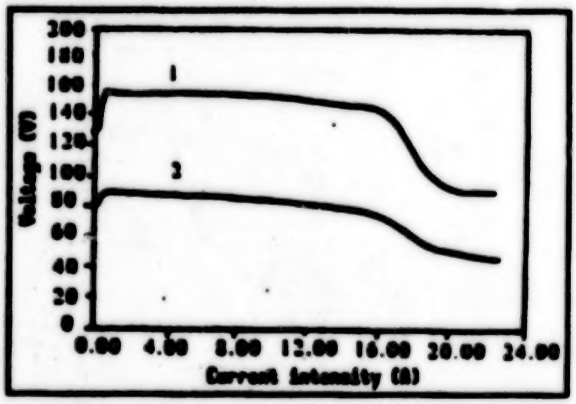

Fig. 3 Discharge characteristics of a 13kW lithium experimental battery

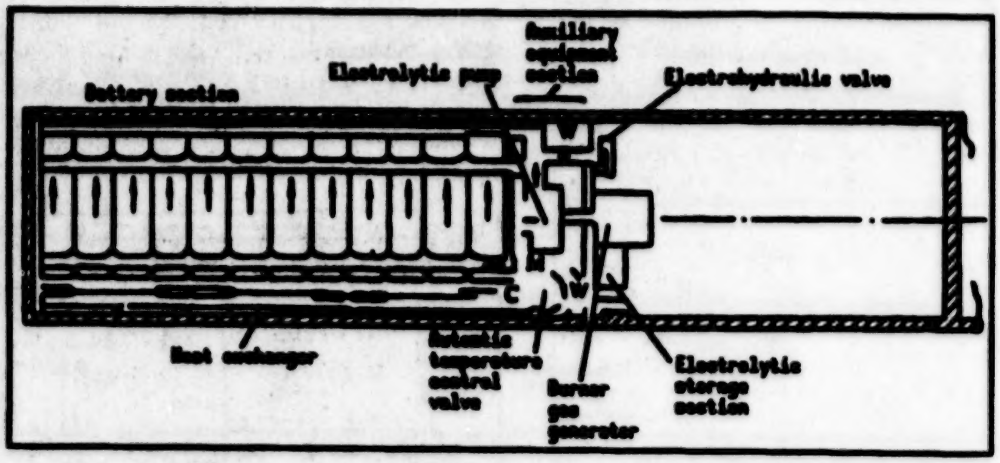

Fig. 4 Schematic of a lithium battery for large-scale torpedoes

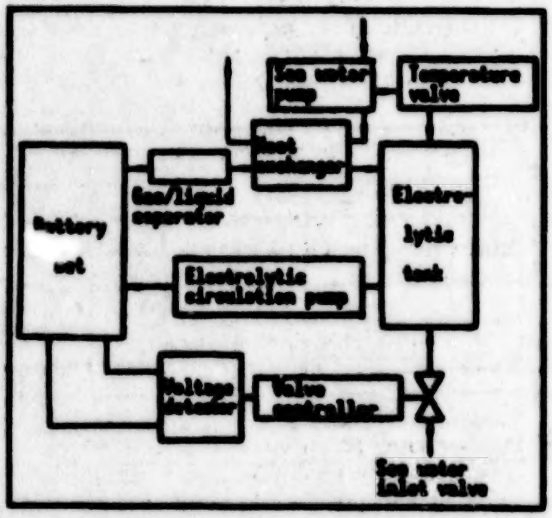

Fig. 5 Block diagram of the auxiliary system of the lithium/silver oxide battery

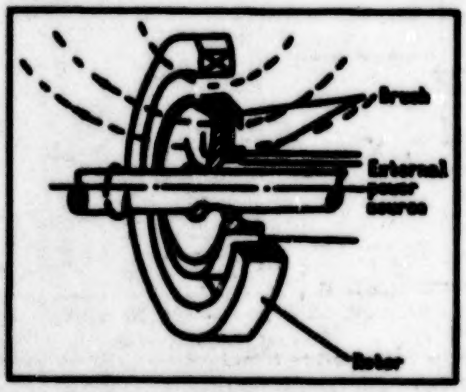

Fig. 6 Schematic of a single-pole dc generator with superconducting magnetic coil

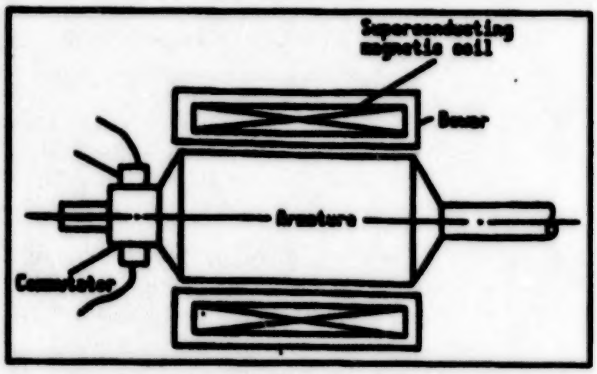

Fig. 7 Schematic of a double-pole generator with superconducting magnetic coil

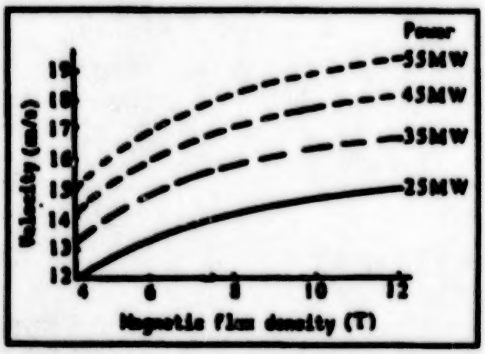

Fig. 8 Relationship between the MHD magnetic flux intensity and the travelling speed of the torpedo

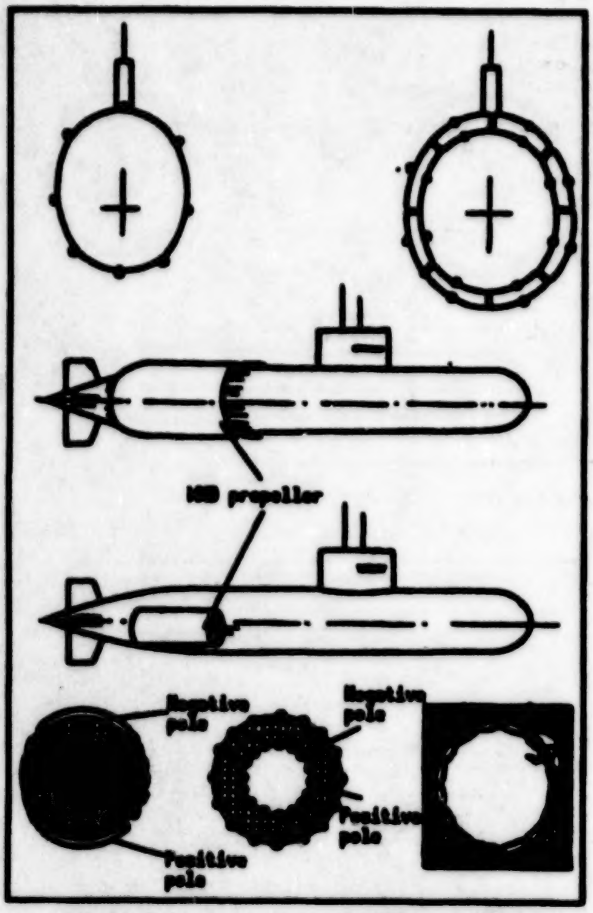

Fig. 9 Schematic of the MHD propeller

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China: Knowledge-Based Target Recognition Algorithm for Complex Backgrounds

963A0011C Hefei MOSHI SHIBIE YU RENGONG ZHINENG [PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE] in Chinese Sep 95 Vol 8 No 3, pp 237-242

[Article by Xing Yan of the Open Laboratory of Artificial Intelligence, Shantou University, 515063, and Zhang Tianxu of the Institute of Image Recognition and Artificial Intelligence, Huazhong University of Science and Technology: "Knowledge-Based Target Recognition Algorithm for Complex Backgrounds"; MS received 7 Aug 94, revised 24 Jan 95]

[FBIS Summary] A knowledge-based, binary-feature-fused, multi-window architecture for algorithms of target extraction and recognition under complex background is proposed. The algorithm consists of two steps: preliminary recognition for the whole image and binary-feature-fused recognition for the interesting windows. With the help of certain prior knowledge, criteria and means of artificial intelligence, targets are extracted, fused and recognized quite well under complex background.

There are six figures shown in the paper: Figure 1 shows the multi-window architecture for algorithms of target recognition; Figure 2 shows a flow chart of the binary-feature-fused algorithm; Figure 3 shows a schematic of the complex criterion (assuming that the total number of edges is 3); Figure 4 shows a schematic of the raw image; Figure 5 shows a schematic of rough-check result; and Figure 6 shows a schematic of the finalized recognition result. There are no tables presented in the paper. References: 3 English, 1 Chinese.

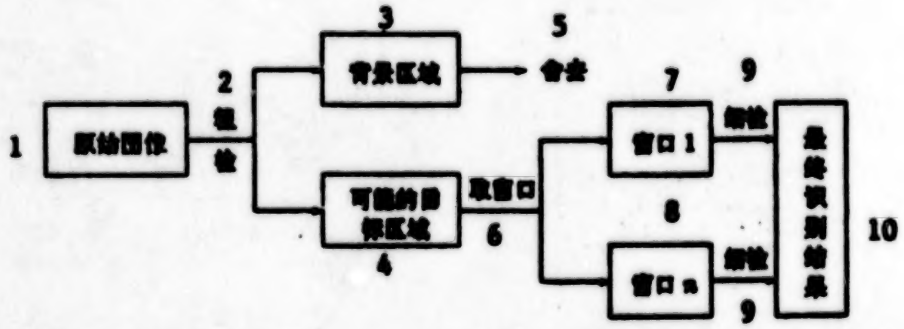

Fig. 1. Schematic of the multi-window architecture for algorithms of target recognition

Key:-)1. Raw image -2. Rough check -3. Background region -4. Possible target region -5. Disregard -6. Windows taken -7. Window 1 -8. Window n -9. Fine check -10. Final recognition result

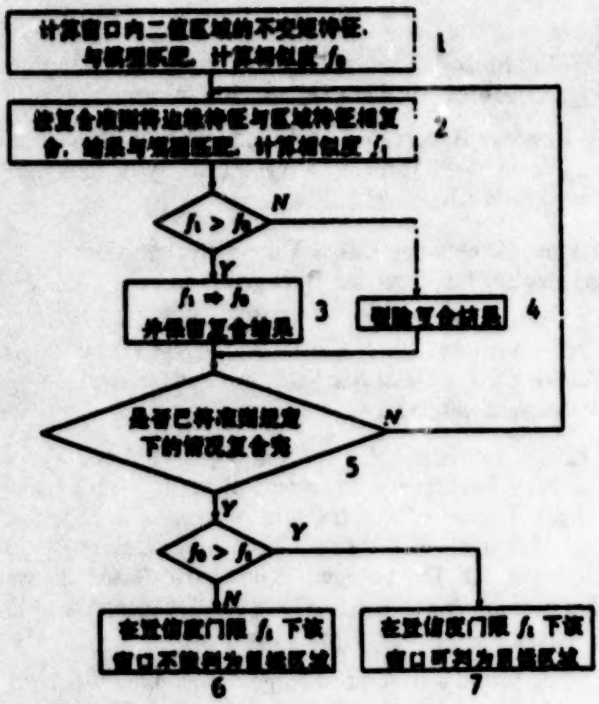

Fig. 2. Flow chart of the binary-feature-fused algorithm

Key:-)1. Compute features of the invariable matrix within the two-value region of the window and match with model, compute similarity f_0. -2. Combine edge features and regional features based on combination criterion, the result is matched with the model, compute the similarity f_1. -3. $f_1 \rightarrow f_0$ and reserve combination result. -4. Delete combination result. -5. Is combination completed under the conditions of the criterion -6. Under the fiducial threshold f_t, the window cannot be determined as target region. -7. Under the fiducial threshold f_t, the window can be determined as target region.

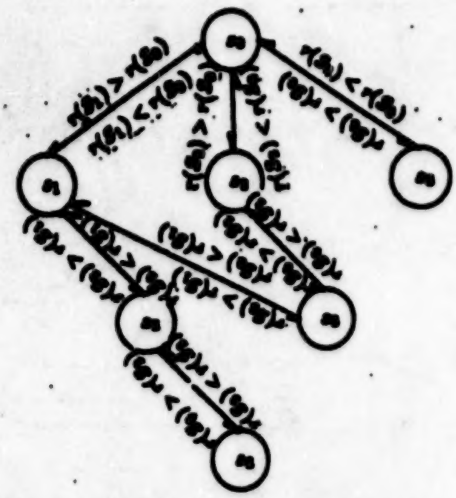

Fig. 3 Schematic of the complex criterion (assuming that the total number of edges is 3)

Fig. 4 Schematic of the raw image

Fig. 5 Schematic of the rough check result (left); Fig. 6 Schematic of the finalized recognition result (right)

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China: Radar Signal Classification Based on Self-Organized Probabilistic Neural Network

963A0011D Changsha GUOFANG KEJI DAXUE XUEBAO [JOURNAL OF NATIONAL UNIVERSITY OF DEFENSE TECHNOLOGY] in Chinese Dec 95 Vol 17 No 4, pp 36-42

[Article by Song Xiaquan, Huang Fukan and Zhou Liangzhu of the Department of Electronic Technology, National University of Defense Technology, Changsha 410073: "Radar Signal Classification Based on Self-Organized Probabilistic Neural Network," MS revised 21 Jun 95]

[FBIS Summary] Based on a self-organized probabilistic neural network (PNN) paradigm, a parallel network can be used to sort data parameters with high accuracy and fragmentation. The PNN implements the statistical Bayesian strategy by computing a joint probability density over all input parameters to match a group of candidate data classes; the sorting is accomplished by assigning the inputs to the most likely group with highest probability density estimate. Then the prospect of applying the self-organized PNN to ESM [electronic support measures] pulse data sorting are shown, and a system including self-organized PNN and pulse repetition interval sorting are discussed under the limited conditions of the sorting after many simulations.

There are three figures: Figure 1 shows a cubical unit which stores the pulse parameters (carrier frequency, direction of arrival (DOA) of signals, pulse width (PW) and time of arrival (TOA) of pulses); Figure 2 shows the structure of the self-organized PNN; and Figure 3 shows a schematic of the sorter for radar signals proposed in the paper. There are three tables which are reproduced below. References: 4 English, 1 Chinese.

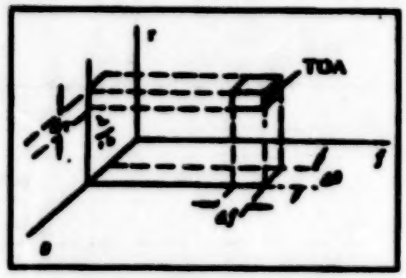

Fig. 1

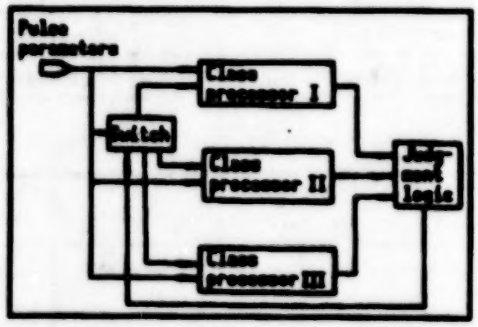

Fig. 2 Structure of the self-organized PNN.

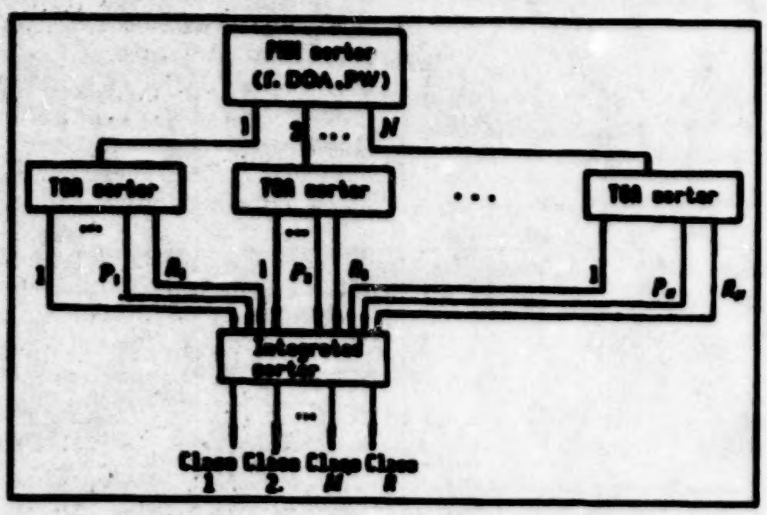

Fig. 3 Schematic of the sorter for radar signals.

Table 1

Parameters	Distribution range of parameters	Accuracy of parameter measurement
Carrier frequency f	1-18GHz	<5MHz(R.M.S.)
Angle of Arrival (AOA)	0-360°	<2°(R.M.S.)
Time of Arrival (TOA)		<0.1 μs
Pulse Repetition Frequency (PRF)	20Hz-10kHz	
Pulse Width (PW)		PW<10 μs, ΔPW<0.1 μs
Pulse Amplitude (PA)	1-50 (Normalized relative intensity	

Table 2

Class (Parameter	Carrier frequency (GHz)	Angle of Arrival (degree)	Pulse width (MACS)	PRF (kHz)
No.1	10.0	10	22	2.2
No.2	10.021	18.5	21	1.9
No.3	10.024	27	25	1.8
No.4	10.063	35.5	22	1.5
No.5	10.084	44	20	1.5
No.6	10.105	52.5	25	2.5
No.7	10.126	61	22	2.0
No.8	10.147	69.5	21	1.7
No.9	10.168	78	21	1.9

Table 3

Radar No.	Type of Radar	Pulse width (μs)	Angle of Arrival (degrees)	Carrier frequency (GC)	PRF (kHz)
1	Conventional	1	5	5	1
2	Conventional	1	17	5	1
3	Conventional	1	29	5	1
4	Conventional	1	41	5	1
5	Conventional	1	53	5	1
6	Conventional	1	65	5	1
7	Double staggering	1	29	5	1, 1.2
8	Double staggering	1	41	5	1, 1.2
9	Triple staggering	1	53	5	1, 1.1, 1.2
10	Triple staggering	1	65	5	1, 1.1, 1.2

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China: Radar Target Identification Based on Eigenpolarization

963A0011E Changsha GUOFANG KEJI DAXUE XUEBAO [JOURNAL OF NATIONAL UNIVERSITY OF DEFENSE TECHNOLOGY] in Chinese Dec 95 Vol 17 No 4, pp 43-50

[Article by Xiao Shunping, Guo Guirong, et al. of the ATR [Aircraft Target Recognition] Laboratory, National University of Defense Technology, Changsha 410073: "Radar Target Identification Based on Eigenpolarization," project supported by grant from National Defense Research Fund, revised MS received 17 Jun 95]

[FBIS Summary] A method to correct the degraded polarization scattering matrix with the least Frobenius norm criterion is presented in this paper. By applying the theory of eigenpolarization, the polarization characteristics of radar targets are abstracted. On the basis of these performances, identification of five types of aircraft is investigated. The results show that this method of identifying aircraft is effective and feasible.

There are a total of 3 figures: Figure 1 shows schematics of five different models of aircraft characterized by the $(\epsilon_\varphi \tau_\varphi)$ parameters; Figure 2 shows graphs of certain types of polarized characterization parameters of the target; and Figure 3 shows a schematic of the structure of the discriminator for the target. There is one table which shows the recognition rate for different types of target. References: 1 English, 4 Chinese.

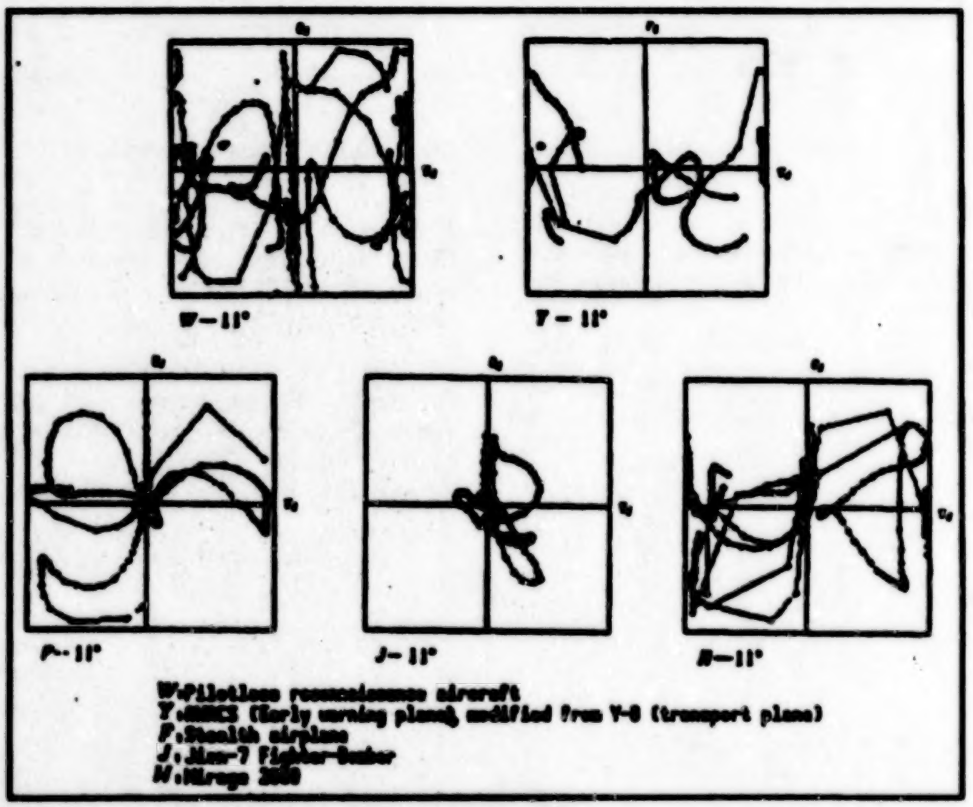

Fig. 1 Schematics of five different models of aircraft characterized by the $(\epsilon_\varphi \tau_\varphi)$ parameters

Table 1

Target attitude	Horizontal roll 0°, pitch angle 0°, azimuth angle 0° to 28°				
Target type	W	Y	F	J	H
Recognition rate	81.3%	84.2%	84.2%	74.0%	81.3%

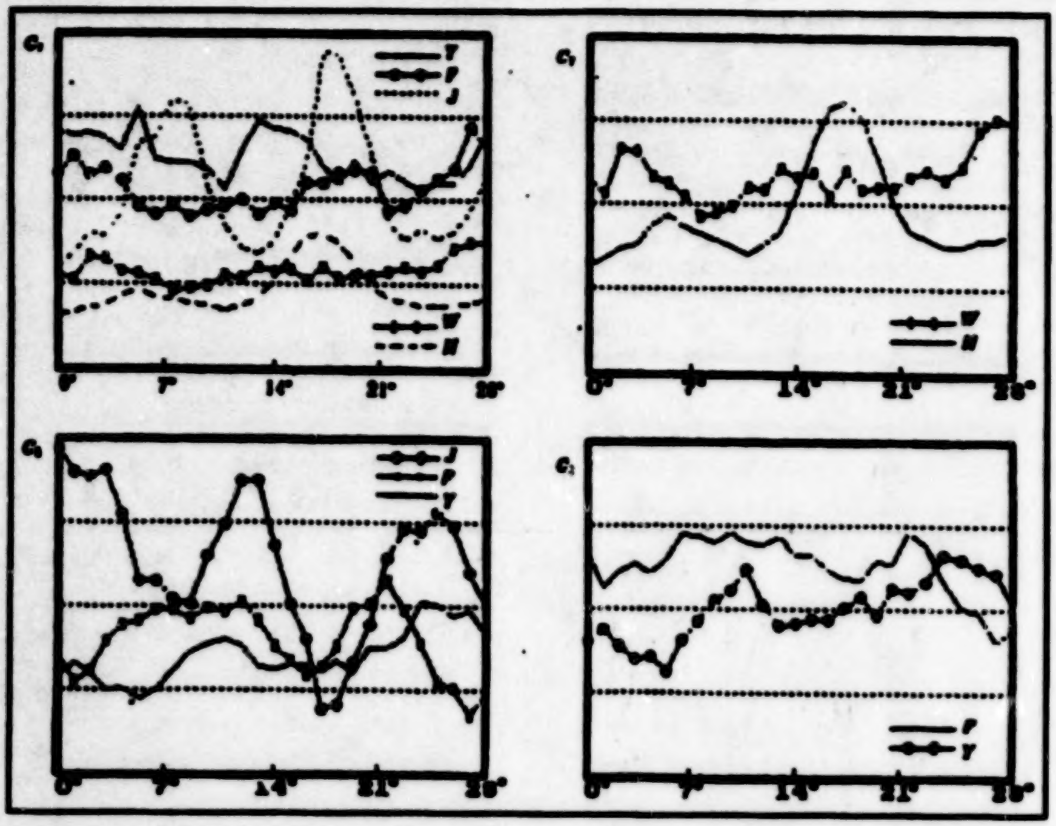

Fig. 2. Graphs of certain types of polarized characterization parameters of the airplanes in Fig. 1

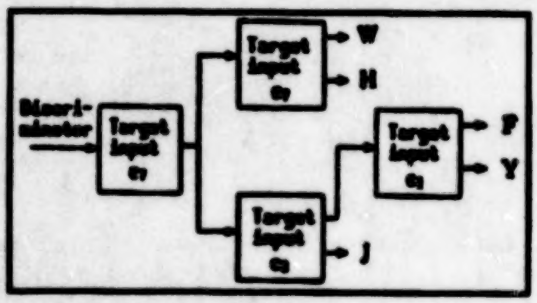

Fig. 3 Schematic of the structure of the discriminator for the targets.

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China: Eighth FYP High-Tech Sensor Achievements Highlighted

963A0028A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 22 Dec 95 p 7

[Article by Lu Deren: "Eighth FYP High-Tech Sensor Achievements Highlighted"]

[FBIS Translated Text] Under the Eighth 5-year plan, nine of the special topics in advanced sensor research recently passed an evaluation by a panel of experts. Most of the achievements have reached international standards of the 90's, and advanced international standards have also been attained on some of the technical parameters in the research.

S&T achievements that have passed the evaluation included the following: controllable-thickness silicon film fabrication technology, solid-phase silicon bonding technology, deep reactive ion etching [RIE] technology, direct-writing technology using laser, floating-bridge microsensor for gas flow measurement, micro acceleration sensor, zirconia substrate pressure sensor, thick-film integrated pressure sensor and acylase enzyme FET sensor and its penicillin G-titer instrument; the last five of the achievements are new technologies in the domestic market or international market.

The achievements indicate that China has mastered the precision technologies required for fabrication of microsensors. These technologies include precision etching for silicon processing, solid-phase silicon bonding technology and precision surface machining technology. By further promoting these technologies, the new emerging field of microsensors can be established in China, thereby widening our market in this field and promoting the quality of life for the Chinese people.

China: Strained Thin-Film Pressure Sensor Developed for Space

963A0028B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 29 Dec 95 p 1

[Article by Li Qiongrui: "Strained Thin-Film Pressure Sensor Developed for Space"]

[FBIS Translated Text] By Reporter Li Qiongrui — A new generation of strained-type, thin-film pressure sensor for aerospace application has been successfully developed by the 48th Institute of the Ministry of Electronics Industry (MEI), and the device passed the evaluation sponsored by the MEI on 24 December. Zhang Xuedong, a Vice-Minister of the State Commission of Science, Technology and Industry for National Defense, and Lu Xinkui, Vice-Minister of MEI, attended the meeting to celebrate.

According to the introduction, the strained-type, thin-film pressure sensor has been widely used in aerospace and military in foreign countries; however, the device has never been used in China. S&T personnel at the 48th Institute made use of their advanced equipment and processing technologies to cooperate with the 704th Institute of the China Aerospace Corporation (CASC) on joint design of the sensor. Recently, the device was field-tested in guided missiles and flying test applications, and it successfully provided the measurement of the combustion pressure of the motor. Favorable evaluations have been received from the units using the device. It has been learned that the product not only has been formally selected to be used in aerospace projects, but also in oil, petrochemical, metallurgy, energy, transportation, light textile and chemical projects.

Experts attending the evaluation meeting unanimously agreed that the new sensor features low zero drift, high precision, stability, excellent dynamic function, wide operating temperature range and ability to operate in a rough environment.

China: Further Details on BGC-161 Image Digitizer Released

963A0028C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 2 Jan 96 p 5

[Article by Xi Er: "BGC-161 Image Digitizer Developed"; cf. FBIS-CST-96-002, 12 Feb 96 pp 100-101"]

[FBIS Translated Text] The model BGC-161 image digitizer developed by Nanjing Optical Instrument Corporation recently passed the technical evaluation test.

The image digitizer is a key component for an image processing system, and China has been importing this type of equipment for a long time. Therefore, it is important for China to develop an advanced, practical, compatible, stable and reliable digitizer, so as to satisfy the needs of the defense and private sectors.

Since the availability of the BGC-161 image digitizer, foreign-made image digitizers can no longer dominate the market in China. The BGC-161 image digitizer features advanced design, state-of-the-art hardware and complete functional software packages.

The design successfully adopts a series of proven technologies, including enclosed air-float guided track, air-float bearing, raster positioning closed-ring control system, high-precision ac servo system, high-quality optical system with high convergence and low stray

light, and high-speed data acquisition, transmission and storage system.

As compared to similar models of imported equipment, the BGC-161 image digitizer features the following: it meets technical standards for minimum pixel size; its normalized speed (maximum data rate of 180 KB/s) is higher than that of the imported models; excellent compatibility for black and white as well as color; compatible transmitted and reflective scanning; compatible dichroic scanning and 3-color scanning; compatible logarithmic (light density) and linear (transmissivity); compatible primary codes and complement codes; and compatible data formats for point intersection, row intersection and waveband sequence.

The BGC-161 image digitizer is simple to operate, is user-friendly and is highly reliable. The digitizer is easy to repair and maintain, and is convenient for use.

China: Sea-Target Multi-Source Recognition System Developed

963A0028D Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 3 Jan 96 p 2

[Article by Li Wei: "Sea-Target Multi-Source Recognition System Developed"]

[FBIS Translated Text] The "Sea-Target Multi-Source Recognition System," a major project under the Eighth 5-Year Plan, was recently developed by the University of Science and Technology for National Defense (USTND). This successful development indicates that China's intelligent military equipment has advanced to a higher level.

Information fusion and target recognition are advanced technologies required by future weapon systems. Making intelligent weapon systems with data fusion is a high priority task for future weapons development. The so-called "intelligent radar" data-fusion system currently being developed and used in developed countries can quickly and intelligently recognize and display any target.

In order to catch up with advanced international standards, a group of professors at USTND assumed this challenging Eighth-FYP project. The "Sea-Target Multi-Source Recognition System" uses advanced technologies and is suitable for China's military radar equipment.

In the appraisal meeting for the developed system, experts believe that the "Sea-Target Multi-Source Recognition System" has combined sensor data-fusion technologies and target recognition theories and techniques, and innovative achievements have been obtained in key technologies of the system. The system can be adapted to many applications.

China: Nation's First High-Performance Optical Scanner Unveiled

963A0028E Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 5 Jan 96 p 8

[Article by Cong An: "Nation's First High-Performance Optical Scanner Unveiled"]

[FBIS Translated Text] It has been learned that optical scanning technologies in China have seen a significant breakthrough: Shanghai General-Purpose Scanning Corporation has developed a new generation of high-performance optical scanners. This new achievement promotes China's technology standard in this field to a world-class level of the 90's. At the project evaluation meeting sponsored by the Shanghai Science Commission, experts as well as foreign and domestic users highly favored the product.

Optical scanners are widely applied in high precision scanning and beam positioning of lasers and infrared beams. Optical scanning is a key technology for printing and typesetting, facsimile transmission, precision laser processing, infrared remote sensing and imaging, laser radar [lidar], and laser advertisement (including big screen display and artistic display); it is used in industrial, commercial, educational, entertainment and defense sectors. Before the development of the optical scanner, China's technology in this field was behind international standards. It has been learned that technical parameters for the newly developed optical scanner meet or exceed the requirements specified by the Shanghai Science Commission. In addition, the scanner conforms to world-class standards in reliability, stability, linearity, accuracy and scanning angle.

China: Ultraweak-Light-Emitting Detection Technology Wins State Invention Award

963A0028F Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 15 Jan 96 p 2

[Article by Wang Jin and Chen Lin: Ultraweak-Light-Emitting Detection Technology Wins State Invention Award"]

[FBIS Translated Text] After receiving a S&T advancement award from the military sector, Dr. Liu Yaning, chief physician at the Air Force General Medical College, recently won another State Invention Award.

Science has proven that a living body is an open, non-balanced, continuously metabolizing system. Cells,

organs and skeletons forming the living body are emitting photons every moment. This ultraweak emitted light is closely related to life activities; it reflects the state of life of living bodies. Liu capitalized on advanced technologies from foreign countries and selected a domestic-made photomultiplier tube to come up with the design of the ultraweak detection device. After tests conducted by the China Institute of Metrology, it was verified that a sensitivity of 10^{-16} watt was obtained in 1988, surpassing the sensitivity of the Japanese-made TD-7 photon counter; and a sensitivity of 10^{-17} watt was obtained in 1991, surpassing that of the U.S. and German products. Furthermore, a much more advanced device with a sensitivity of $6x10^{-18}$ watt was developed in 1994, surpassing that of the international product standards of 10^{-16} to 10^{-17} watt. The device developed by Liu features an ortho-normalized optical path, which collects the weak stray light from human bodies, thereby enhancing the sensitivities in measurement and surpassing the standards of U.S., Japanese, German and Russian products. Liu received a China patent for his invention in 1991. By use of the detection device, Liu has proposed some new phenomena which have drawn international attention, including hemoprotein oxidation light emission, light emission from virus-affected cells, and optical flux variation in the eustachian tube. Currently, the newly developed device is in production.

It is learned that the ultraweak light-emitting detection technology developed by Liu has expanded its application from the biomedical field to the environmental, electro-chemistry, prescription drug screening, seed germination and food industries.

China: New Sensors From Beijing Institute of Information Engineering Highlighted

963A0028G Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 16 Jan 96 p 5

[Article by Li Qiongrui: "New Sensors Developed by Beijing Institute of Information Engineering"]

[FBIS Translated Text] Significant achievements in sensor development have been obtained at the Beijing Institute of Information Engineering (BIIE) under the Eighth 5-Year Plan. The Electronic Sensor Institute of BIIE has completed 22 sensor development projects assigned by the State Planning Commission, State Commission of Science, Technology and Industry for National Defense, Ministry of Electronics Industry and National Natural Science Foundation. The projects have been approved and accepted by respective units, and favorable comments have been received from experts on the topic.

The "tactile sensor system for underwater robots" developed by BIIE can recognize more than 10 types of underwater steel and copper materials, oilstone, marble, ceramics, glass, leather, plastic and foam, etc. The recognition rate is higher than 90%, the recognition time is less than 5 seconds, and the average underwater trouble-free interval is more than 5,000 hours. The successful development of this sensory system has a positive meaning in promoting the development of underwater robotics in China. In addition, BIIE has also used fluidics to successfully develop an inertial sensor for gas flow — the piezoelectric fluidic rate sensor and pendulum angle-of-inclination gas sensor are first of their kind in the domestic market. The angle-of-inclination sensor provides a span of +45° with a resolution of 0.01°; its nonlinearity is less than 1%. Not only can it be used in aerospace, aviation, ships and weapons control systems, but also in private sectors such as robots, automobiles, drilling platforms, construction and transportation for measurement of tilt angle.

The type 03A piezoelectric composite material not only possesses the strong piezoelectric effects of piezoelectric ceramics, but also the softness and low reactance of organic piezoelectric materials. Its technical characteristics surpass the world-class level of the early 90's, and it can be widely used in a variety of instruments, including underwater sound, ultrasound and medical instruments.

China: Study on GSMBE Growth of InGaAs/InP Superlattice Materials

963A0010A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Oct 95 Vol 16 No 10, pp 725-729

[Article by Sun Dianzhao, a senior engineer and researcher at the Institute of Semiconductors, the Chinese Academy of Sciences, Beijing 100083, and Wang Xiaoliang, a lecturer of the Xian Institute of Optics and Precision Mechanics, the Chinese Academy of Sciences, Xian 710068: "Study on GSMBE Growth of InGaAs/InP Superlattice Materials"; MS received 8 Jun 94, revised 5 Oct 95]

[FBIS Summary] This paper presents a study on the successful growth of InGaAs/InP strained- and nonstrained-layer superlattices on the crystal orientation of (100) InP substrates using an asymmetrical switching method. The Gas Source Molecular Beam Epitaxy (GSMBE) technology is employed on the first China-made Chemical Beam Epitaxy (CBE) system. The three samples are characterized by a high-resolution X-ray diffractometer, and In composition in the InGaAs quantum well layers is calculated. The design widths of the wells of the three samples are 40 to 50 angstroms. The results show that the superlattices grown on the CBE system with the technology have good quality.

Three figures, not reproduced, show the double-crystal X-ray diffraction curves of the three samples (the x-axis shows the diffraction angle and the y-axis shows the intensity). Figure 1 shows the curve of matched superlattice (sample 1), in which seven single-sided satellite peaks can be seen; Figure 2 shows the curve of nonstrained superlattices (sample 2), in which five single-sided satellite peaks can be seen; and Figure 3 shows the curve of strained superlattices (sample 3), in which 12 single-sided satellite peaks can be seen. References: 6 English.

China: High-Efficiency AlGaAs/GaAs Solar Cell: Fabrication, Irradiation, Annealing Effects

963A0010B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Oct 95 Vol 16 No 10, pp 741-746

[Article by Li Biao, Xiang Xianbi, et al. of the Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, and by You Zhipu of the Department of Physics, Sichuan University, Chengdu 610064: "High-Efficiency AlGaAs/GaAs Solar Cell: Fabrication, Irradiation, Annealing Effects"; MS received 20 Jan 94, revised 10 May 94]

[FBIS Summary] High-efficiency $Al_xGa_{1-x}As$/GaAs ($x>0.8$) solar cells are fabricated by the liquid phase epitaxy (LPE) process. Conversion efficiencies of 18.65% (1.08 cm^2) and 17.33% (2x2 cm^2) are respectively exhibited under one sun, air mass zero (AM0) conditions (uncorrected for contact area). The experimental results indicate that the shallow-junction cell is more resistant to 1 MeV electron radiation than the deep-junction cell, while the density and the number of deep-level traps induced by irradiation can be reduced after thermal annealing.

The solar cell is fabricated according to the following process: cutting, grinding and polishing of the crystal; preparation of liquid for epitaxial growth; a two-step epitaxial growth process, in which an n-type layer is grown first and a p-type AlGaAs window layer is grown next; photolithography and vacuum evaporization for the electrode; and alloying.

Six figures, not reproduced, show a chart of the I-V (current vs voltage) characteristic curves of the AlGaAs/GaAs solar cell and charts of changes in electrical parameters (open-circuit voltage, short-circuit current, efficiency, etc.) of different samples after irradiation and thermal or time-controlled annealing. There is one table which shows the dosage of irradiation of different samples of the solar cell. References: 10 English, 2 Chinese.

China: Silicon Quantum Wire Array Embedded in Silicon Dioxide

963A0010C Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Oct 95 Vol 16 No 10, pp 798-800

[Article by Shi Yi, Liu Jianlin, et al. of the Department of Physics, Nanjing University, Nanjing 210093: "Silicon Quantum Wire Array Embedded in Silicon Dioxide"; supported by grants from State "863" High-Tech Program, the Climbing Program and the NSFC; MS received 26 Jan 95, revised 27 Apr 95]

[FBIS Summary] A silicon quantum wire array embedded in thermally grown silicon dioxide has been fabricated successfully by using normal silicon processing technology, reactive ion etching, anisotropic wet chemical etching, thermal oxidation and super-low-pressure CVD [chemical vapor deposition] technique. Scanning electron microscope shows the high-quality silicon quantum wires clearly with the width down to 20 nm. It is found experimentally that the dimensions of the silicon quantum wire can be precisely controlled

by selecting the temperature of the thermal oxidation process.

There is only one figure which shows a schematic of the silicon quantum wire array structure. This type of quantum wire array has many features: it is made of monocrystalline silicon, which has a complete crystal structure; the quantum wire array with high-quality Si/SiO_2 heterostructure has a high potential barrier for carriers (electrons or holes); the quantum wire has a precise location and dimension, which are beneficial for the study of physical properties and devices; and the fabrication process is compatible with the processing of large-scale silicon integrated circuits.

References: 8 English, 2 Chinese.

China: Growth of GaN by MOCVD

963A0010D Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Nov 95 Vol 16 No 11, pp 831-834

[Article by Lu Dacheng, Wang Du, et al. of the Semiconductor Material Science Laboratory, Institute of Semiconductors, the Chinese Academy of Sciences, Beijing 100083: "Growth of GaN by MOCVD"; MS received 9 May 94, revised 22 Jun 94]

[FBIS Summary] Gallium nitride (GaN) is an important semiconductor material operating in the blue light range. GaN epitaxial layer was successfully achieved by metal-organic chemical vapor deposition (MOCVD) with trimethylgallium (TMGa) and NH_3 as sources on (011[bar]2)α-Al_2O_3 (sapphire) substrate. The epitaxial growth of GaN was achieved in a locally made normal pressure horizontal quartz reaction chamber. The morphological, crystalline, electrical and optical characteristics of the GaN film are investigated. The crystalline properties of the epitaxial layer are characterized by X-ray diffractometer and double-crystal X-ray diffractometer, and the electrical properties are measured by Van der Pauw technique. The minimum full width at half-maximum (FWHM) of the (21[bar]1[bar]0) peak of the double crystal X-ray diffraction rocking curve is 16 min. Cathode luminescence of the ultraviolet and visible light released from GaN are observed.

Three figures, not reproduced, show a chart of the X-ray diffraction spectrum of the GaN epitaxial layer, a chart of the GaN transmitted spectrum at room temperature, and a chart of the 80 K cathode-luminescent spectrum of GaN.

References: 16 English, 2 Chinese.

China: Optically Pumped External Cavity Surface-Emitting InGaAs/InP Semiconductor Laser

963A0010E Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Nov 95 Vol 16 No 11, pp 854-856

[Article by Xiang Wanghua of the Department of Precision Instruments, Tianjin University, 300072, and by S. Machida, et al. of the NTT Basic Research Laboratories, Musashinoshi, Tokyo 180, Japan: "Optically Pumped External Cavity Surface-Emitting InGaAs/InP Semiconductor Laser"; MS received 20 Jun 94, revised 1 Sep 94]

[FBIS Summary] The experimental results of an external cavity surface-emitting InGaAs/InP semiconductor laser are reported. Using a 3-μm-thick semiconductor material $In_{0.53}Ga_{0.47}As$/InP (grown by a molecular beam epitaxy (MBE) process) as the gain medium, and a mode-locked (or continuous) Nd^{+3}:YAG laser at a wavelength of 1.32 μm as the pump source (pump threshold power of 430 mW), an average power of 187 mW and a super-short pulse width of 6 ps at an output wavelength of 1.5 μm are achieved. The pulse width can be compressed to 181 fs with a diffraction grating pair.

One figure, not reproduced, shows a schematic of the experimental setup of the InGaAs/InP semiconductor laser. The setup includes a dichroic lens M1, which has a high transmission rate for the pumped light and a high reflective rate for the signal light; an output lens M2 with a transmission rate of 10%; a focusing lens (f=48 mm); a double reflective filter (thickness=1 mm, bandwidth=30 nm); and a block of $In_{0.53}Ga_{0.47}As$/InP surface-emitting semiconductor material used as the gain medium. The substrate for the block is InP (thickness 430 μm). The back of the sample is coated with a layer of full reflective film, which forms an optically resonant cavity with M1 and M2; the entire media is attached on a heat sink plate and sealed inside a nitrogen tank.

References: 6 English.

China: Optical Properties of High-Energy N^+-Implanted GaSb

963A0010F Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Nov 95 Vol 16 No 11, pp 879-884

[Article by Zheng Yuxiang, Su Yi, et al. of the T.D. Lee Physics Laboratory and Department of Physics, Fudan University, Shanghai 200433: "Optical Properties

of High-Energy N+-Implanted GaSb"; MS received 26 May 94, revised 4 Sep 94]

[FBIS Summary] This paper presents a study of crystal defects and optical properties of the 2 MeV high-energy N+-implanted GaSb by use of different techniques including photoluminescence (PL), elliptical polarized spectroscopy (SE), [Rutherford] back scattering and channel technique (RBS/C), and scanning electron microscopy (SEM). The results indicate that the high-energy N+-implanted GaSb crystal will not produce anomalous swelling; and by selecting the annealing conditions, the lattice of the implanted sample can be recovered. The results from SE technique can precisely reflect the lattice defects of the implanted sample, and it is verified that they are in agreement with the results from the RBS/C technique. By fitting the SE results with an effective media analog (EMA), a quantitative knowledge about the damage of the samples is obtained.

Four figures, not reproduced, show a chart of the RBS/C of the implanted sample (number of channel vs amount produced), a chart of the pseudo-dielectric function spectrum of the sample, a chart of the RBS/C of the sample (after RTA annealing), and a chart of the experimental curves by fitting the SE results with the EMA.

References: 7 English.

China: GaAs IC CAD System Certified

963A0030A ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 29 Dec 95 p 1

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Zheng Zhaolin

Recently in Shijiazhuang, a R&D project dealing with key GaAs integrated circuit (IC) computer-aided design (CAD) technology was evaluated and passed the acceptance test at a meeting chaired by the Ministry of Electronics Industry (MEI). This research was targeted for priority under the National Eighth FYP and was coordinated by Research Institute #13 of MEI. Participants in the project included: Research Institute #55, Qinghua University, Southeast University, Shanghai Jiaotong University, Hangzhou College of Electrical Engineering, and UESTC. Among the important key technological areas that were addressed were large MIMIC [microwave monolithic IC] CAD systems and large very-high-speed IC (VHSIC) CAD systems. The evaluating committee believes that the capabilities of China's MIMIC CAD systems are already on a par with similar international software products of the early 1990's. The VHSIC CAD systems meet international standards of the mid and late 1980's.

China: 1-Micron VLSI ASIC Fabrication Techniques Pass Acceptance Tests

963A0030B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 2 Jan 96 p 5

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Meng Xin

Recently, a meeting was convened at Qinghua University to administer acceptance tests for a project involving key technological problems receiving national priority treatment under the Eighth FYP. The Ministry of Electronics Industry (MEI) was in charge of the meeting. The project to be considered was entitled "Research on 1-Micron-Class Very-Large-Scale Integration (VLSI) Application Specific Integrated Circuit (ASIC) Fabrication Techniques." Building on the foundation established by the solving of key technological problems during the Seventh FYP, the results achieved in this project include perfecting fabrication processes and raising product yields. Twelve batches of chips have already been produced, representing a finished product yield of 7.2% and total production of 8000 chips meeting all specifications. Moreover, the new technology has been transferred to the Huajing Electronics Group. This is the first time that a comprehensive domestically developed 1.5-micron processing technology has been successfully transferred to the industrial sector. Those in attendance at the meeting unanimously voted to approve and pass this technology. The project was carried out by the Qinghua University Microelectronics Institute.

The experts in attendance at the meeting believe that this project provides valuable experience as China develops its own comprehensive VLSI fabrication technology. They also believe that this project lays a foundation for the development of sub-micron fabrication technology.

Among the important research results are an improved fabrication line using 4-inch rather than 3-inch wafers and enhancements in fabrication capabilities and productivity with capabilities for fabricating a variety of products (38 types of ASICs have been developed on the fabrication line). In addition, the following technologies were developed: 2-micron n-well, p-well and standard twin-well CMOS technologies; double-layer poly-Si technology; two-layer aluminum wiring technology; 1.2-micron n-well CMOS technology; EEPROM technology; high-low voltage mixed CMOS circuit technology; and low leakage electrical component technology. Of these nine modular fabrication technologies,

the EEPROM and the low leakage electrical component technologies are in the forefront of domestic technology.

The process control monitors (PCM) that were used to monitor and diagnose problems in the nine technologies played an important role in the successful development of each modular fabrication technology and each ASIC. An applied client/server system was set up in the course of this project; better system process control was attained along with other new capabilities; comprehensive improvements were made in the design of the user interface; and, for the first time, SYBASE system data was used in the programming and development of a VLSI computer-aided manufacturing (CAM) system.

In the course of the project, 1-micron class ASIC fabrication technologies were successfully applied to a 10,000-gate gate array and in the development of 8-bit reduced instruction set computing (RISC) chips. A 1.2-micron n-well CMOS 10,000-gate gate array was produced as well as three types of 1.5-micron RISC application circuits.

As this research is incorporated into IC products which are in demand in the marketplace, the high level of processing capabilities offered by these fabrication line technologies will become clearer. This high technology can be dovetailed with the efforts of China's IC backbone enterprises, thus amply verifying the scientific rationale for paying special attention to these research topics.

China: 12 New ASICs from CASC's Ninth Academy Certified

963A0030C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 2 Jan 96 p 5

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Ren Aiqing

Recently in Beijing, the China Aerospace Corp. (CASC) convened a meeting for evaluation of 1995 achievements in application specific integrated circuits (ASIC) which also served as a design finalization meeting. At the meeting the following achievements were certified: three types of rocket-borne telemetry transmission equipment ASICs developed by the ASIC Laboratory of the CASC Institute for Basic Electronics Research (CASC's Ninth Academy); three types of digital receiver ASICs; two types of expandable parallel computer cluster system ASICs; and four types of military-use transmission relay ASICs.

The digital receiver ASICs (XGQ3, NCO2 and JEKO2) are the key components of this device. These ASICs play a crucial role in reducing the weight, volume and power dissipation of digital receivers as well as increasing system capabilities and dependability. The evaluation committee found that all three of these circuits have a comparatively large number of buses and that input and output are mutually dependant, with complex sequential relationships that put severe demands on components in terms of the interrelated lag-times. By optimizing overall circuit structure and the macro-units, the look-ahead carry accumulator was creatively combined with the anticipated carry generator to implement multi-digit high-speed accumulation. There had been problems stemming from the complex buses and their effects on the wiring layout of the gate array with its fixed routing channels. These problems were resolved by technical means such as changing the sequence and designated layout of components placed in the circuit. The input-output sequences of the three types of circuits were integrated and the testing scheme was optimized so that more comprehensive testing is now possible. The three different types of circuits use gate-array masterslices of equivalent technological sophistication, thus guaranteeing high performance throughout the entire system. Successful development of the digital receiver ASICs puts an end to China's total dependence on foreign imports for these products and will play a significant role in promoting and accelerating the development of telemetry and digital communications technologies for civilian and military use.

The expandable computer cluster ASICs (SN1080 & SBI) that were certified are the key components of the "Expandable Parallel Computer Cluster System" which is funded under the State 863 Program. There are a comparatively large number of buses and complex sequential relationships in these two circuits. Moreover, there are many internal triple gates which are used to control bidirectional transmission, making it more difficult to design these ASICs. In the process of developing the design, the logic of the circuit was reconstructed and optimized and the data channels were rearranged. These improvements were implemented by optimizing the macro-units, using bit-slice technology to analyze the circuit logic, and by the use of partitioned organization. By these means, solutions were found for problems stemming from the complex buses and their effects on the wiring layout of the gate-array with its fixed routing channels. The testing diagrams were analyzed and optimized so that more comprehensive testing is now possible. The successful design and development of these two circuits confirms the correctness of the designs proposed by Beijing Univ. of Aeronautics & Astronautics [Computer Dept.] for an expandable parallel computer

cluster system. This success fills in a domestic gap as far as attention to this kind of research. Moreover, it will play a significant role in promoting the development of this type of high-speed parallel computer cluster system.

In regard to the rocket-borne telemetry transmission equipment ASICs (the EAD circuit for memory control, the INF circuit for HPROM control and the DIC circuit for the digital interface) and the military-use transmission relay ASICs, the evaluation committee found that they feature sensible designs and advanced technologies and that they were developed in a short period of time. These circuits reach the highest domestic standards for integrated circuit performance and dependability.

China: Additional Details on CASC's New ASICs

963A0030D Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 8 Jan 96 No 2, p 6

[FBIS Translated Text]

JISUANJI SHIJIE dispatch based on information supplied by CASC

On 20-21 December 1995 in Beijing, the China Aerospace Corp. (CASC) convened a meeting for evaluation of 1995 achievements in application specific integrated circuits (ASICs) which also served as a design finalization meeting. Among the ASICs that were certified at the meeting were: three types of missile-borne telemetry transmission equipment ASICs (EAD, INF and DIC circuits); three types of digital receiver ASICs (XGQ3, NCO2 and JEKO2); and expandable computer cluster SN1080 and SBI ASICs, as well as a MUX1 multiplex module, a MUX2 branch-off module, an ERD1 recovery function circuit and a DLL synchronous recovery circuit.

The rocket-borne remote control transmission equipment ASICs have already been used successfully in the Y12-01 on-board telemetry transmission equipment of CZ-2C/FP launch vehicles. The digital receiver ASICs were proposed by Institute #704 in light of the need to accomodate various tasks performed by a variety of models and were developed by the ASIC Laboratory of CASC's Ninth Academy. Successful development of the digital receiver ASICs puts an end to China's total dependence on foreign imports for these types of products. The expandable computer cluster ASICs are the key components of the "Extended Parallel Computer Cluster System" which is funded under the State 863 Program. The successful development of these circuits confirms the correctness of the designs proposed by BUAA [Computer Dept.] for expandable parallel computer cluster systems. This success fills in a domestic gap as far as attention to this kind of research.

The evaluation committee found that the successful development of these circuits was the result of close coordination between the user's systems engineers and the developer's systems engineers. The circuits feature sensible designs and advanced technologies and reach the highest domestic standards for IC performance and dependability.

China: Domestically Made High-Power IGBT Certified

963A0030E Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 5 Jan 96 p 8

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporters Chu He and Ma Zewen

Recently a national priority technology project under the Eighth FYP was certified after a technological appraisal. This was a project undertaken by the Center for Research and Development of New Electrical Power Electronics Technology. A high-power insulated-gate bipolar transistor (IGBT) and an IGBT module were successfully developed during this project.

This is the first time that China has produced an IGBT and an IGBT module. All of the appraising experts found the 1000V/50A/20KHz IGBT chip and module and the 1200V/90A/20KHz IGBT chip and module to be up to international standards of the late 1980's and early 1990's, thus filling in a gap in terms of domestic technology.

The high-power IGBT has been dubbed the "perfect technology" and belongs to the third generation of electrical components for electrical power applications. It is a high-power IC component which combines metal-oxide semiconductor (MOS) and bipolar technologies. In terms of performance, the component has the low voltage drop and high current density of bipolar components as well as the fast switching speed and good frequency characteristics of MOS components. In terms of manufacturing technology, thyratron manufacturing technologies characterized by high voltages and high currents and the microscopic processing technologies used for making ICs are employed in the manufacture of these components. For these reasons, the IGBT is now recognized as one of the most promising power switching components for achieving power frequency translation in high-power and medium-power applications.

China: Huajing Group Builds 'Project 908' VLSIC Production Line

963A0030F Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 8 Jan 96 No 2, p 1

[FBIS Translated Text]

Dispatch filed by JISUANJI SHIJIE reporter Zhang Longquan

The Huajing Electronics Group of China recently announced that construction has officially begun on one of the highest priority projects in China's electronics industry—the Huajing "Project 908" very-large-scale integrated circuit (VLSIC) production line project.

The total investment for the project will be 1.39 billion RMB and construction is expected to take 16 months. The project will build on Huajing Group's scientific research capabilities and its presently existing production facilities for ICs. Their #88 plant and power facilities will be retooled so that eventually the VLSIC production line will be capable of producing 10,000 6-inch diameter wafers per month. AT&T technology will be introduced for this project and eventually 0.8-micron to 1.0-micron production will be possible. Moreover, an excellent foundation will be laid for production in the 0.5-micron class. Once production begins, it will be possible to produce 50 million VLSICs annually, generating sales revenues of 700 million RMB and tax remittances to the state of 190 million RMB. The ICs produced will find wide applications in communications, computers, industrial controls and various consumer goods.

According to informed sources, the pertinent state authorities are paying close attention to the construction of the Huajing project in order to assure that construction proceeds quickly, with maximum quality and minimum cost. To this end they have already appointed a leadership group for the Huajing "Project 908." A Vice-Minister of the State Planning Commission, Zeng Peiyan, will serve as the advisor to the group. Executive Vice-Minister of Electronics Industry Liu Jianfeng will serve as the chairman of the leadership group.

China: Fudan ASIC State Key Lab's Eighth FYP Achievements Highlighted

963A0030G Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 16 Jan 96 p 5

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Xin

Recently the Ministry of Electronics Industry (MEI) convened and chaired a meeting at Fudan University to appraise and consider projects for certification. Three national priority science and technology projects dealing with key technological problems under the Eighth FYP were certified. These projects were carried out by the Fudan University Application Specific Integrated Circuit (ASIC) State Key Lab and were entitled "Research on the FD9201 Digital Switch Circuit," "Research on Microcontroller Very-Large Scale Integrated Circuit Hardware Description Language (VHDL) Technology" and "Research and Development of FPGA [field-programmable gate array] Applications in System Integration Technology."

The experts, academicians in the Chinese Academy of Sciences (CAS), unanimously found that each of these three projects fill important gaps in domestic technology and that each project has great significance towards raising China's design and development capabilities in the area of very-large scale integrated circuits (VLSIC).

The Fudan University ASIC State Key Lab has now completed all of its 22 national priority science and technology projects dealing with key technological problems under the Eighth FYP.

China: IC Testing Achievements Highlighted

963A0030H Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 17 Jan 96 p 6

[FBIS Translated Text]

Dispatch filed by KEJI RIBAO reporter Zhi Jianwei

China's first independently produced platform for the development of IC testing mainframe programs has been completed in Beijing. The system is independently copyrighted and was appraised by experts in late December of 1995 and granted state certification.

In the past few years, with the rapid progress in IC technology and particularly application specific integrated circuit (ASIC) technology, the necessary development of testing programs has become a bottleneck in the design, verification and development of these components. Moreover, among the various aids that are used in the IC computer-aided engineering (CAE) environment, aids for the development of testing programs are comparatively poor. This phenomenon of uneven progress in the production of development tools is very apparent in China. During the period of the Eighth FYP, researchers at the Institute of Computing Technology of the Chinese

Academy of Sciences, the Beijing Automated Testing Technology Research Institute and Shanghai Jiaotong University joined together to tackle key technological problems and independently produce a large software platform for the development of testing programs—the "Testing Development System" (TeDS). This system is geared towards China's most representative IC testing systems and automated test equipment (ATE) as well as China's most representative computer-aided design (CAD) systems. The system can generate tests from the CAD phase to the ATE phase. Programs that may be used on a number of ATE machines feature high portability. Moreover, the system provides for the development of testing programs for off-line testing of each separate ATE machine. The system is an integrated development environment that provides comprehensive support to developers of testing software. The TeDS features an industrial standard computer hardware platform and an industrial standard operating system platform (UNIX and DOS), X-Windows and MS Windows graphical interface environments, and C and C++ languages. The TeDS system features a comprehensive, independently designed "intermediate format language". At the same time, when it is applied to the testing languages of the various ATE machines, the system becomes an environment for the development of off-line testing programs with an excellent user interface. Thus the system is easy to use, can be easily expanded, and features a full range of functions. It will greatly lower the cost of developing testing programs and increase the efficiency of the development process.

This system has been well received by experts and users. The unanimous opinion has been that the TeDS provides a development environment that is advanced in its organization, open, and easily expandable. Software engineering has been used to create a system that integrates test program generation, portability and development of off-line testing programs. Much of the work on this system meets international standards of the 1990's. Production of the TeDS will certainly have a profound and stimulating effect on China's development of testing programs for ICs and there is a wide vista of applications for this system.

China: Further Progress on IC Testing Noted

963A0030I Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 18 Jan 96 p 5

[FBIS Translated Text]

Dispatch filed by KEJI RIBAO reporter Zhang Dong

On December 6 1995, a national priority science and technology project dealing with key technological problems under the Eighth FYP was appraised by experts and received state certification. The project is entitled "Development of a Testing Program Library" and was undertaken by the Beijing Automated Testing Technology Research Institute (BATTRI), under the authority of the Ministry of Electronics Industry (MEI).

ICs may be used in a broad range of electronics applications and the testing of ICs is an essential facet of guaranteeing the quality of the many different types of electronics products. In the process of dealing with some of the key technological problems under the Seventh FYP, BATTRI brought together nearly 100 experts and technical personnel from around the country to carry out research on the methods and technology of IC testing. This group produced a set of testing programs and put together China's first large IC testing program library. During the Eighth FYP, the testing program library was further developed, expanded and perfected. The testing laboratory was equipped with capabilities for performing verification, evaluation and inspection tests as well as capabilities for solving highly complex testing analysis problems related to ICs.

As of today, the arrangement and contents of the library have been put in good order and this is now an advanced, pacesetting, practical library. The library contains more than 1000 testing programs covering the main categories of ICs that are in wide domestic use. Among the more than one dozen categories of IC testing programs in the library are programs for testing CPU and microcontroller ICs, memory ICs, communications processing and communications interface ICs, hybrid analog-digital communication ICs, analog-to-digital converter ICs and digital-to-analog ICs. All of these programs have been thoroughly examined and inspected. By self-tests of the programs, as well as comparison tests and topical acceptance tests, the programs were tested at every level to make sure that they were up to standard, thus insuring that every program in the library has undergone examination and inspection and that each program will yield reliable test data. Among the testing products that have been completed and which reach current advanced international standards are a testing package for application-specific hybrid analog/digital communications ICs, testing programs for 16-bit microprocessor and coprocessor ICs, a testing package for color television ICs, a testing package for analog-to-digital and digital-to-analog converter ICs, testing programs for special memory ICs, testing programs for programmable logic array (PLA) ICs and testing programs for application-specific communications interface ICs and communications processing ICs.

In the process of tackling key technological problems under the Eighth FYP, the technical personnel at BAT-

TRI have also made earnest efforts to disseminate the testing program library and put it to use, thus helping to meet the challenge of developing a specialized IC testing technology for all of China. In conformance with the 25 leading principles enunciated by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) in their "General Requirements for Standardization and Testing Laboratories" which are part of the ISO-9000 series of standards, BATTRI has drawn up a quality control handbook, established a comparatively rigorous set of measures to guarantee quality, and established various regulatory regimes. These measures have been taken so that "notarized testing, rigorous standards, accurate measurements, scientific analysis and high-quality service" may become the motto of the workplace. In recent years, over 1/3 of the testing programs in the library have already been used in extensive testing services provided in over a dozen domestic factories, research institutes and various other work units.

China: CAS Shanghai Institute of Metallurgy's Eighth FYP IC Achievements Noted

963A0030J Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 19 Jan 96 p 1

[FBIS Translated Text]

Shanghai dispatch filed by ZHONGGUO KEXUE BAO reporter Huang Xin and correspondent Gao Yongjin

The Shanghai Institute of Metallurgy (SIM) of the Chinese Academy of Sciences (CAS) has undertaken nine national priority projects dealing with key technological problems under the Eighth FYP. The projects are concerned with the development and manufacture of integrated circuits and, a few days ago, they were appraised and granted national certification by a committee that was chaired jointly by the Ministry of Electronics Industry (MEI) and CAS.

By strenuous efforts to tackle key technological problems, and building on the foundation created by R&D on a number of different normalized and standardized fabrication technologies, the technical personnel in the Microelectronics Division of SIM have established eight modular standard fabrication technologies and their corresponding IC forward design databases. The technologies established include: manufacturing technology for a 1.0-micron, two-layer, metal wiring, dual well CMOS IC; manufacturing technology for a 2.0-micron, two-layer, metal wiring CMOS IC; manufacturing technology for a 2.0-micron bipolar-CMOS hybrid IC; and fabrication technology for a 2.0-micron high-speed bipolar IC. Building on these fabrication technologies, in 1995 SIM developed a total of 34 types of application specific integrated circuits (ASICs) and was entrusted with the task of manufacturing these circuits. They are now being used in the computer industry, communications, the automobile industry, the defense industry, and in consumer goods. Some of these circuits have already gone into small-lot production and ever greater economic and social benefits are being realized from these ASICs.

At the same time that SIM was tackling key technological problems and achieving the results described above, its Microelectronics Division was establishing the Shanghai Microelectronics Research Center for National Projects. A fully equipped IC production line has been completed featuring the most up-to-date, sterile conditions. 1.0-micron ICs can be manufactured on the production line, characterized by stable operation and a rigorous system of controls. A wide variety of ICs can be developed and manufactured within a short period of time with a comparatively good yield. A complementary ASIC design environment has also been established. The building of the Shanghai Microelectronics Research Center for National Projects will facilitate progress in the development of IC manufacturing and will usher in the next generation of technology. The center will also become the experimental base for the development of technology that will feature sophisticated engineering as well as adaptability to the needs of industry and the requirements for large-scale production.

The appraisal committee has found that the technological results described above are of great practical value and that they are highly significant in relation to the development of China's microelectronics industry.

China: CAS Institute of Electrical Engineering Develops Sub-Micron E-Beam Exposure Machine

963A0030K Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 22 Jan 96 p 2

[FBIS Translated Text]

Dispatch filed by ZHONGGUO KEXUE BAO reporter Wu Fengyu

The Institute of Electrical Engineering of the Chinese Academy of Sciences (CAS) has undertaken a national priority applied research project under the Eighth FYP entitled "Research on the DY-5 Sub-Micron E-Beam Exposure Machine." Recently in Beijing, the project was evaluated favorably in a technological appraisal carried out by a committee chaired by academician Wang Shouwu.

E-beam exposure technology is a computer-controlled technology for extremely minute processing. In this technology, an electron beam is directed towards a mask plate or wafer surface to which an electron-resist material has been applied, thus etching the pattern that is to be used in the semiconductor component. This E-beam machine uses a general purpose high-end minicomputer. A pattern generator exposes the work to electrons using a dual path vector scanning technique. Since the E-beam machine has field adjustment capabilities, it is able to make patterns that cover a large area by splicing together contiguous fields. Patterns may be placed and spliced to a precision of +/- 0.15 microns. The high-precision X-Y axes workpiece platform can accommodate a 100 mm by 100 mm masking plate or a 75-mm-diameter wafer. Real-time measurements of the displacement precision of the machine are made using a dual frequency laser interferometer; the position resolution is 0.02 microns.

The E-beam machine is equipped with six lanthanum boride high-intensity cathodes and is also compatible with tungsten cathodes. Because this machine has scanning electron microscopy (SEM) capabilities, it is easy to use and simple to operate.

During the development process, the E-beam machine was used to make sub-micron patterns as requested by a number of work units; in each case the pattern was a success. Among the patterns produced was the pattern on an X-ray lithography masking plate for use in production of surface acoustic wave (SAW) transducers. SAW devices have already been produced using this masking plate. The pattern was commissioned by the CAS Microelectronics Center and the CAS Institute of High Energy Physics.

The appraisal committee unanimously found that this is cutting edge domestic technology.

China: Eighth FYP Breakthroughs in IC Fabrication Equipment Noted

963A0030L Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 23 Jan 96 p 1

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Ma Zewen

In a national priority project that tackles key technological problems under the Eighth FYP, equipment used for the production of ICs has been manufactured by the Beijing Jianzhong Machine Shop (BJMS). The shop has manufactured key equipment for the production of 1-micron line-width ICs including reactive ion etching (RIE) equipment, low-pressure chemical vapor deposition (LPCVD) equipment and plama-enhanced chemical vapor deposition (PECVD) equipment. In addition, it has manufactured key equipment for the manufacture of 3-micron ICs, including RIE equipment, diffusion furnace systems and four probe testers. Recently this project was appraised by an expert committee chaired by the Ministry of Electronics Industry (MEI) and was granted certification.

BJMS is one of the key Chinese electronics industry enterprises involved in the development and manufacture of equipment used for producing semiconductor ICs. This national priority project for tackling key technological problems includes the manufacture of essential equipment used in 6-inch wafer very-large scale integratated circuit (VLSI) production lines. The experts on the committee found that the important 1-micron and 3-micron production equipment manufactured by BJMS successfully addresses the key technological problems to be solved. This is the first time that a Chinese enterprise has applied a number of advanced technologies towards the resolution of problems in VLSI production equipment, thus increasing the level of automation and the dependability of the equipment and bringing various technologies used in domestic IC production equipment up to a new plateau, including diffusion system technology, CVD technology and RIE dry etching technology. The technology in this project meets international standards of the late 1980's and represents leading, or even pioneering, domestic technology. The four probe testers represent leading-edge advanced international technology featuring high-precision testing and exceptional performance in regard to taking evenly distributed and numerous measurements within a small area. These testers can take resistivity measurements and also can generate statistical information. They are highly suitable for IC fabrication monitoring applications, they feature a high degree of automation and a wide range of selectable functions, and they meet the demands posed by the real world.

China: Ordnance Industry Unit Develops Monolithic 14 Bit A/D Converter

963A0030M Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 25 Jan 96 p 2

[FBIS Translated Text]

Dispatch filed by KEJI RIBAO reporter E Jie

Research Institute #214 of the Chinese Ordnance Industry has undertaken an Eighth FYP national priority project sponsored by the National Defense Science, Technology and Industry Commission (NDSTIC) entitled "Research on Complementary Metal-Oxide Semi-

conductor (CMOS) Monolithic IC 14-Bit A/D Converters." This project, which involves expertise from a number of disciplines, was favorably evaluated by an expert appraisal committee on Jan 24.

Fast and accurate 14-bit A/D converters are absolutely essential devices in certain military weapons and in industrial automated control systems. Currently, only the USA and a few other developed countries are able to produce these converters. The cost of importing a single converter IC chip varies between several hundred and several thousand RMB and China has to expend a large amount of foreign exchange each year to buy these chips. In accordance with the current international trend towards high-technology, accurate A/D converters, Research Institute #214 has used both advanced error correcting technology and charge redistribution switched-capacitor array technology to independently design and develop a perfected 3-micron silicon-gate CMOS fabrication technology for 14-bit A/D converters. A circuit with extremely complex capabilities has been placed on the surface of an 8.7 X 7 mm chip. Among the features integrated into the chip are an application-specific microprocessor, static random-access memory (SRAM), a high-precision automatic zero-setting voltage comparator, an operational amplifier, a low-temperature-drift/constant-current-source bias system, an internal oscillator, a charge redistribution switched-capacitor array and a self-correcting error compensation array. This is the first time that a monolithic IC 14-bit A/D converter has been developed in China. Moreover, the converter meets military-use requirements for operation in a temperature range from -55° to +125°C. It represents a major breakthrough in the design and fabrication technology for fast, high-resolution A/D converters. This is the highest resolution monolithic A/D converter that China has ever produced. In terms of capabilities and performance, it meets advanced international standards for similar products.

The successful development of this IC will serve to greatly accelerate the development of those application-specific integrated circuits (ASICs) that are so urgently needed in key Chinese industries such as the communications and computer hypermedia industries, as well as those circuits needed in the "Three Golden Projects." This IC will also give an impetus to the progress of Chinese microelectronics technology.

China Masters 1-Micron Megabit-Class IC Production Techniques

963A0030N Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 29 Jan 96 p 1

[FBIS Translated Text]

Dispatch filed by KEJI RIBAO reporter Ji Hoagguang

A national priority Eighth FYP project for tackling key technological problems entitled "Research on 1 to 1.5-Micron IC Large-Scale Production Technology" was reviewed favorably on Jan 18 by an expert appraising committee in Wuxi. Later, on Jan 24, the project was granted state certification in Beijing. This signifies that China has been able to grasp the principles of large-scale production technology for 1-micron megabit-class ICs by relying on its own development capabilities.

Microelectronics technology forms the basis for an expanding electronics information industry and the microelectronics industry is a strategic industry which indicates the real economic strength of a country. The developed countries have consistently blocked the introduction of cutting-edge microelectronics technology into China. This is a national Eighth FYP project that is being undertaken by the Central Research Institute of the China Huajing Corp. The project requires a large investment, deals with key difficult technological problems, and is extremely pertinent to the subject of large-scale production. The technical personnel leading the project have made development of the national microelectronics industry their primary objective. Building on Qinghua University's solutions to key technological problems under the Seventh FYP as well as advanced foreign technology, these technical personnel have independently completed their task and solved a new set of technological problems. In January of 1995 they successfully developed China's first standard 1-Micron IC—the CSC245. Then they went on to develop an extremely complex 40,000-gate "sea-of-gates" complementary metal-oxide semiconductor (CMOS) IC, a 1-megabit masked ROM chip and a 256 kilobyte static random-access memory (SRAM) chip. Of the 13 new products developed, the masked ROM chip and the telephone set dialing circuit had already been put into commercial large-scale production before the termination date for the project.

The experts attending the certification meeting emphasized that the mastering of this basic 1-micron technology has not only given China the initiative as it enters the comparatively large market for 1-micron ICs, but also, by fundamentally strengthening China's confidence in its own ability to develop a prosperous microelectronics industry, the achievements realized have both established a substantial foundation for further development of micron-class technology and partially created the conditions necessary for R&D at the next higher level of technology—the sub-micron class.

At the meeting where certification of the project was announced, Minister of Electronics Industry Hu Qili noted that this project combined both theoretical research and attention to problems in production while considering both the military and civilian sectors and incorporating industrial and academic research. He said that, by using this approach, this project has blazed trails for further development of the national electronics industry in the future.

Shougang NEC Brings China Into 6-Inch, 0.5-Micron-IC Era

963A0030C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 30 Jan 96 p 1

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Meng Xin

On Jan 23, Shougang NEC announced the official beginning of its project to raise the level of technology, boost investment and expand production. This action will make Shougang NEC the pioneer in raising the level of China's IC technology to the 6-inch, 0.5-micron stage, thus bringing China's industrial IC production technology into the sub-micron era.

This project supplements a 26 billion yen investment with an additional investment of 12 billion yen and will result in raising the level of technology and expanding production capacity. The goals for raising the level of technology are to introduce sub-micron technology from NEC Japan and to go into large-scale production of products featuring 0.56-micron technology before the end of 1996 as well as introducing 0.72-micron technology for the production of application-specific circuits for program-controlled [telephone] switching systems and other devices. The goals for expanding production capacity are to bring the production line for the early stages of fabrication from the present monthly capacity of 3000 wafers up to a monthly capacity of 8000 wafers as well as to bring the production line for the later stages of fabrication from its present annual capacity of 40 million circuits up to an annual capacity of 80 million circuits. Among the new products that have been added are: dynamic memory [DRAM] circuits; circuits for program controlled devices; gate-array circuits; single chip microcomputers; and application-specific integrated circuits (ASICs).

Shougang NEC was formed as a joint venture between Shougang Corporation's head office and Japan's NEC Corp. Shougang NEC's products are widely used in computers and communications, and in household appliances. In 1994, the production line was put into operation, including all stages of fabrication. In that year, equipment was used to its maximum capacity and the yield for the various types of products was between 94% and 96%. Few other companies engaged in this type of production have been able to achieve full production capacity so quickly with such a high yield. Moreover, Shougang NEC has already reached the level of performance of NEC Corporation's foreign subsidiaries. In order to continue to maintain its leading position vis-a-vis similar domestic enterprises, and in order to meet advanced international industrial production standards, Shougang NEC decided to raise the level of technology, boost investment and expand production, thus making great strides towards meeting advanced world standards.

China: Shougang NEC's Revenue Breaks 900 Million RMB Mark

963A0030P Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 30 Jan 96 p 5

[FBIS Translated Text]

Dispatch filed by ZHONGGUO DIANZI BAO reporter Meng Xin

On 23 January, reporters gathered at Shougang NEC Corporation learned that annual sales revenues for Shougang NEC broke the 900 million RMB mark in 1995. Tax remittances to the state of 268 million RMB were realized.

In April of 1994, Shougang NEC's production line for the later stages of fabrication officially began large-scale production. Wafers began to be manufactured on the production line for the early stages of fabrication in November of the same year. Shougang NEC is primarily engaged in the design, development, production and marketing of very-large scale integrated circuits (VLSI). It has a thoroughly equipped diffusion production line and IC packaging production line as well as a center to do the related IC design and development work.

In 1995, Shougang NEC's production line for the early stages of fabrication produced about 28,000 wafers during the year. The production line for the later stages of fabrication produced 43 million circuits during the year. The ratio of domestic to foreign product sales was 5:5. [as published]. Shougang NEC has already joined the front ranks of those domestic enterprises engaged in this type of production. At present it has the highest sales revenue of all the Chinese enterprises engaged in IC production.

China: Ministry of Public Security Requires Registration for Internet-Access Units

96P30163A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 15 Feb 96 p 1

[Article by reporter Zhang Wentian]

[FBIS Summary] The Ministry of Public Security (MPS) recently issued "Notification of Registration of Computer Information Systems Accessing the Internet." This directive requires that units and individuals involved with computer information systems accessing the Internet must go through the formalities of registering with the offices of the public security organs at the prefectural/municipal level or county/municipal level within 30 days after the network formally connects [with the Internet].

China's 2-year history of Internet access has benefited the nation's economic, cultural, and S&T development—in terms of information exchange, resource sharing, and S&T cooperation. At the same time, since some computer information systems during the course of accessing the Internet have lacked security management, some negative actions have arisen.

During an interview with this reporter, MPS Computer Management and Oversight Department Assistant Director Yang Zhihui [2799 2535 1979] indicated that the new directive is a major move by the MPS organs to strengthen computer security management, to promote the healthy development of the nation's information industry, and to enhance security administration for the "information highway."

China: Beijing-Wuhan-Guangzhou Class-1 Fiberoptic Cable Trunk Line Project Completed

96P30163B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 15 Feb 96 p 6

[Article by reporter Huang Dingguo]

[FBIS Summary] Construction on an Eighth FYP Key Project—the Beijing-Wuhan-Guangzhou (Buried) Class-1 Fiberoptic Cable Communications Trunk Line—was formally completed on 24 January. This 2886-km-long trunk line, crossing five provinces and one municipality, uses 36-fiber cable and includes 12 140-Mbps systems (1B1H coding, 3120 telephone circuits per system). Gross investment was 610 million RMB. This trunk line project was initially designed by MPT's Design Institute. Channels for the buried cable were dug by 40,000 PLA troops and fiberoptic cable laying and connections were overseen by the China Construction Corporation. The trunk line uses domestically developed and manufactured optoelectronic equipment throughout. The entire 12-system trunk line has a gross capacity of 164,620 long-distance circuits, of which the class-1 trunk line uses 45,600 circuits. The remaining circuits are allocated to the class-2 trunk line and to city-to-county regional communications.

China: Golden Construction Project (National Information Construction System) Under Way

96P30163C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 16 Feb 96 p 8

[Article by reporter Zhu Lingzhen; cf. early report in FBIS-CST-96-005, 27 Mar 96 p 30]

[FBIS Summary] The Ministry of Construction's Information Center has announced that the "National Information Construction System" (known as the "Golden Construction Project"), after over a year of policy and technical preparations, has now entered the implementation phase. It is estimated that information centers will be built in 622 cities nationwide within 3 years. The project is designed to disseminate information on the construction industry, government affairs and regulatory information, S&T information, and market information. The entire project consists of a public database, an industry database, and a specialized application system.

China: Three Major Modern Communications Networks in Shanghai Operational

96P30163D Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 16 Feb 96 p 3

[Article by reporter Jin Congan]

[FBIS Summary] On 4 February at the Shanghai Municipal Exposition Center, the Shanghai Municipal Government Press Office and the Municipal P&T Management Bureau held a joint ceremony to commemorate the formal opening of three major modern communications networks in Shanghai. On a large screen, viewers could see Shanghai municipal government officials and computer industry leaders demonstrating these three major new networks, which provide a major boost to continuing construction of Shanghai's "InforPort."

The first of these, the Shanghai commercial Integrated Services Digital Network (ISDN), provides users with 2B+D broadband digital channels over a pair of conventional telephone copper wires [i.e. unshielded twisted pair, or UTP]. This ISDN can interconnect a maximum of eight dissimilar-type terminals, with up to three terminals communicating at once. In addition to regular telephone service, the Shanghai ISDN permits videotelephony, data communications, high-speed faxing, and

teleconferencing. By the end of this year, all 50 telephone end offices in Shanghai municipality will have equipment providing these functions.

The second network, the Shanghai Radio Packet Data Experimental Network, consummately integrates wireless mobile communications and computer data technologies. Ordinary PCs, portable PCs (notebook computers), and vehicle-borne intelligent terminals can all communicate within a 100-km radius. The only requirement is a wireless modem.

The third network, the Shanghai ATM [asynchronous transfer mode] Broadband Communications Experimental Network, is the nation's first broadband communications network. Incorporating the IBM Company's newest technology, this network meets the latest 1990s international standards. The network's functions include text and graphics dialog, long-range video-on-demand (VOD) feature-film showings, and high-speed data transfer.

Guangzhou Builds Nation's First Broadband Multimedia Experimental Network

96P30163E Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 28 Feb 96 p 5

[Article by reporter Han Wen]

[FBIS Summary] In Guangzhou, the Guangdong Province P&T Management Bureau is funding the construction of China's first broadband multimedia communications utilitarian experimental network. Network customers, with a controller connected to their TV [i.e. a "set-top box"], can select—with computer-style menus—between a film, news, an educational program, financial information, etc. The desired film, program, or other information begins within 3 seconds of selection, and can be changed at will via the controller. The Guangdong P&T Bureau imported the technologies and equipment for this network from DEC in the U.S. and—together with Zhongwang Commercial Machinery Ltd.—conducted R&D of broadband multimedia network services. The network became operational in January 1996 and currently has 50 customers. The Guangdong P&T Bureau is now doing research on expanding the network to serve users in industry, the home, the office, medical institutions, universities and colleges, and research institutes.

China: Bay Networks Builds Shanghai's First 155-Mbps ATM Network at Fudan University

96P30163F Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Mar 96 p 6

[FBIS Summary] The U.S. firm Bay Networks recently held a press conference to announce that officials building Fudan University's new-generation campus network have selected Bay Networks' most advanced ATM [asynchronous transfer mode] switching technology for the network backbone. Fudan University [in Shanghai] thus becomes one of a very few institutions of higher learning in the Asia-Pacific Region to get an ATM campus network. Fudan University is the first of the seven key educational institutions selected in the State 211 Plan to get such an ATM network, which is also Shanghai's first 155-Mbps campus network. The Fudan network is a member of the Shanghai InforPort Project, the Shanghai Educational and Research Network [SHERNET], the Shanghai Internet, and CERNET.

The Fudan University Campus Network, whose systems integration is being overseen by the Shanghai Chang Jiang Group, consists of eight main nodes, a main server, an applications server, an ATM switch, appropriate network-access equipment, and a host computer. The network, which complies with the X.25 protocol, integrates wireless microwave communications, DDN [digital data network] dedicated lines, and a variety of conventional LANs. Network functions include point teleconferencing, real-time multimedia searches, and other broadband services.

Sino-Korean Undersea Fiberoptic Cable System Operational

96P30163G Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Mar 96 p 5

[FBIS Summary] State United Information Network release — Opening ceremonies for the Sino-Korean Undersea Fiberoptic Cable System were respectively held the other day in Beijing and Seoul, with the participants linked via a television/telephone system. This 549-km-long system, running from China's Qingdao to the ROK's Taean, consists of two 560-Mbps systems, each with a capacity of 7560 digital circuits.

NSM, China's Telecom Firms Reach Agreement on Providing of Advanced Telecom Equipment to China

96P30163H Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Mar 96 p 6

[FBIS Summary] The U.S. firm National Semiconductor Ltd. and Hong Kong Chengde International Ltd.'s joint-venture entity NSM International Ltd. recently agreed in Beijing to form a joint venture with companies belonging to several Chinese government organs. The new joint venture will manufacture advanced telecommunications and information transmission products in China. The new joint venture's Chinese investment partners include the China Electronic Systems

Equipment Engineering Company (CESEC) and China Posts & Telecommunications Industrial Corporation—Zhongxun Posts & Telecommunications Industry Technical Services Center (PTIC-CTC). To be called Zetong [3419 6639] Telecommunications Ltd., this joint venture will make and sell advanced digital cordless communications products conforming to the wide-area DECT (Digital European Cordless Telecommunications) system standard. These products have a variety of applications—including voice, data, graphics, and multimedia communications—in the home, business, and public sectors.

China: MPT, Lucent Technologies Jointly Build Beijing-Wuhan-Guangzhou Communications Artery

96P30163I Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 13 Mar 96 p 6

[Article by reporter Yin Hongqun]

[FBIS Summary] China's MPT and AT&T's systems and technology arm Lucent Technologies on 6 March reached an agreement whereby the latter will supply the world's most advanced SDH [synchronous digital hierarchy] transmission equipment to MPT for the Beijing-Wuhan-Guangzhou Trunk Line Project. The agreement actually encompasses two SDH contracts, including one for the SDH transmission equipment used in the 2886-km-long Beijing-Wuhan-Guangzhou plow-in fiberoptic cable trunk line. This equipment includes four 2.5-Gbps transmission systems. This contract's total value is over $19 million. The other SDH contract, signed by the two parties on 7 February, specifies Lucent Technologies' provision of SDH equipment to MPT for the Beijing-Kowloon-Guangzhou fiberoptic cable trunk line.

The Beijing-Wuhan-Guangzhou trunk line, a main north-south "artery" in the Ninth FYP "eight longitudinal by eight crosswise" fiberoptic cable trunk line network, will interconnect Beijing with Shijiazhuang, Zhengzhou, Wuhan, Changsha, and Guangzhou.

Shanghai Gets China's First Residential ATM Fiberoptic Network

96P30163J Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 18 Mar 96 No 11, p 2

[Article by reporter Yue Ziqiang: "Shanghai's Jinhua Residential Demonstration Area Will Get ATM Fiberoptic Network"]

[FBIS Summary] The nation's first modern residential area to use an ATM [asynchronous transfer mode] fiberoptic network will take shape on a 11.4-square-km plot of land—a "dream park come true—in the Jinhua District of Shanghai's Pudong New Area. This announcement follows upon the agreement reached among Shanghai's Lanshen, the 3Com Corp. [of the U.S.], and Shanghai's Liuli Modern Living Area Development Company. This network project will incorporate a number of high technologies such as multi-cell information and automated communications. Using 3Com's ATM comprehensive resolution scheme, this network will have 3Com CELLPLEX 7000 ATM switches and Link Switch 2700 intelligent switching equipment. The Jinhua Minidistrict, to be completed in June of next year, will have optical fiber carrying information at a rate of 155 Mbps as it enters each high rise in Jinhua; the information is then sent to the individual users over PDS integrated wiring at a rate of 10 Mops.

China: AT&T, MPT Reach Agreement on Beijing-Kowloon-Guangzhou Fiberoptic Cable Trunk Line

96P30163K Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 20 Mar 96 p 5

[Article by reporter Qun Yan]

[FBIS Translated Text] AT&T Beijing Fiberoptic Cable Ltd. and MPT reached agreement the other day in Beijing whereby AT&T will provide MPT with fiberoptic cable for the Beijing-Kowloon-Guangzhou Fiberoptic Cable Trunk Line. The total contract value is $4.2 million. The 3400-km-long Beijing-Kowloon-Guangzhou Fiberoptic Cable Trunk Line uses 48-core fiber, of which six cores will be the first domestically made dispersion-shifted fiber. According to this contract, AT&T and MPT have jointly signed a contract with a total value of $6.8 million for the Beijing-Kowloon-Guangzhou Fiberoptic Cable Trunk Line. This marks the first application of AT&T's bundle-tube fiberoptic cable in a [China] State Class-1 trunk line.

China: Key Telecom Research Areas, Technologies for Ninth FYP Specified

96P30168A Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese Feb 96 No 2, pp 3-6

[Article by Jiang Yong [1203 8673] of the Science and Technology Dept., MPT]

[FBIS Summary] MPT has designated the following nine key research areas and technologies in its Ninth 5-Year Plan (FYP):

(1) **The China National Information Infrastructure (CNII).** This includes developmental research on information theory, key technologies, standards, and interfaces; planning for the formation of a [national] high-speed information network and industry; planning for

the structure, targets, design, standards, policy, and implementation of the CNII; and selection of geographical areas for local experiments in high-speed information network transmission.

(2) **Integrated Services Digital Networks (ISDN).** Narrow-band ISDN (N-ISDN) applications, software, and hardware will be developed and disseminated in the economically developed regions and for government departments and other authorities. Some broadband ISDN (B-ISDN) communications services, built around asynchronous transfer mode (ATM) technology, will be introduced in certain economically developed regions; this work will be preparatory to and serve as the technical foundation for a post-2000 formal establishment of a [national] B-ISDN network.

(3) **Fiberoptic Communications.** Trunk-line construction will mainly employ SDH [synchronous digital hierarchy] equipment, with important nodes to use DXC4/4 [digital cross-connect standard 4/4]. Internode transmission speed will be 2.4 Gbps, with some traffic in the larger regions going at 10 Gbps or via 4 x 2.4-Gbps wavelength-division multiplexing (WDM) systems. The main nodes for intraprovince communications will use DXC4/1 equipment or ADM [expansion not certain, probably either adaptive delta modulation or asynchronous disconnect mode] optical repeater equipment with cross-connect functions. Interprovince communications will use 155 Mbps, 622 Mbps, or 2.4 Gbps [i.e. SDH's STM-1, STM-4, and STM-16 standards, respectively]. Subscriber networks will mainly use fiber-in-the-loop (FITL) based on passive optical networks (PONs) or they will use hybrid fiber-coax (HFC) networks. The nodes will use ADM or optical loop concentrators (OLCs). Research priorities include all-optical communications based on optical amplifiers, optoelectronic integrated circuits (OEICs), and optical integration (OI).

(4) **Wireless Communications.** Microwave communications will basically develop toward high-speed, multimode modulation and adaptive cross-connect, polarized, interference-cancelling technologies for 2 x 155-Mbps SDH digital microwave (DMW) systems. These systems will replace the existing analog microwave systems. For mobile communications, stress will be laid on CDMA [code-division multiple access] technology, high-speed pager coding system technologies, 1.8-2.2-Gbps microcell systems, personal communications services (PCS), digital public cordless telephone systems, and tracking of research and technical developments for the Future Public Land Mobile Telephone System (FPLMTS). Satellite communications will develop toward high-frequency, high-speed broadband, digitized and integrated-services networks. The main frequency bands for satellite communications will be C-band spreading [i.e. spread-spectrum], Ku-band, and Ka-band. Stress will be on development and manufacture of ground-station system equipment, digital satellite communications systems, VSAT systems, subscriber satellite systems, low-cost rural satellite communications systems, and satellite mobile communications systems.

(5) **Access Networks (ANs).** R&D will concentrate on V5 interface technologies permitting SPC switches and digital subscriber loops to develop toward broadband ANs. Fiberoptic subscriber networks will move toward fiberoptic subscriber loops, PONs, fiberoptic TDMA [time-division multiple access] and CDMA technologies, low-loss fiber, subscriber fiberoptic cables, and the like. Also stressed will be research on integration of High-Speed Digital Subscriber Line (HDSL), Asymmetric Digital Subscriber Line (ADSL), and wireless-access technologies into the existing metal subscriber lines, and development of broadband interactive services by R&D of cable TV systems and technologies.

(6) **Intelligent Networks (INs).** Based on user demand, large-scale development of IN services will take place. Focus will be on R&D of systems and technologies for ciphony frame recording (200), callee-paid services (800), virtual private networking (VPN), telephone tickets, mass calling, and INs based on service control points (SCPs) and supporting Signaling System No 7 (SS7). Specific SS7 technologies to be studied include MTP [message transfer part], SCCP [signal connection control part], TCAP [transaction capabilities application part], and INAP [IN application part].

(7) **Support Software for Telecommunications Network Management and Operations.** Computer technology and "Open System" [i.e. OSI-based] architectures will be used—together with CASE [computer-aided software engineering] tools, software testing/manufacturing tools, and software engineering methods—to develop appropriate telecommunications management network (TMN) principles, practices, and operations.

(8) **Integrated Services Multimedia Communications.** New integrated multimedia services—such as telemedicine, teleteaching, expert system evaluation, home shopping, and home showings of [viewer-selected] feature films—will be gradually developed and popularized. Utilitarian integrated-services multimedia communications systems are to be developed; these systems will include multimedia and hypermedia information retrieval systems (M&HIRS), video on demand (VOD), and personal videoconferencing systems (PMIC) [exact expansion unknown].

(9) **Communications Power Supplies.** Here the focus will be on raising power-supply and power-feed efficiencies, saving on energy resources, and development of intelligent, concentrated control.

China: New High-Power, Long-Pulse Klystron Developed for Fusion Research

96P30166A Chengdu DIANZI KEJI DAXUE XUEBAO [JOURNAL OF THE UNIV. OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA (UESTC)] in Chinese Feb 96 Vol 25 No 1, pp 52-58

[Article by Li Mingguang [2621 2494 0342], Cheng Cide [2052 4379 1795], and Yin Jinzhao [3009 6855 3564] of the Institute of High-Energy Electronics, UESTC, Chengdu 610054, an SSTC 863 High-Tech Project; MS received 3 Nov 95, revised 13 Nov 95]

[FBIS Summary] Design, technology, and tests results of a new S-band, high-power, long-pulse klystron—intended both for RF plasma heating and for lower hybrid current drive (LHCD) experiments—are described. The cavity frequencies, drift lengths, and output gap impedance are optimized with the aid of a one-dimensional electron disk model computer program. Developed after several technical hurdles were overcome, this klystron manifests high-power, high-efficiency, and high-gain performance under long-pulse operation. The device has been successfully used as a high-power microwave (HPM) source for the LHCD nuclear-fusion experiments with the the HL-1M tokamak.

Main optimal measured parameters for this klystron are as follows:

- center frequency = 2450 MHz (best from five tested)
- output power = 446 kW
- pulse width = 40 ms
- efficiency = 57.1 percent
- gain = 55.7 dB
- injector operating voltage = 61 kV
- injector current = 12 A
- drift-tube length = 157 mm
- overall device height = 1.8 m
- device gross weight = 120 kg

Additional design parameters are listed as follows:

- bandwidth = 10-20 MHz
- lifetime = 1000 hours
- perveance = $0.928 \times 10^{-6} AV^{-2/3}$
- drift-tube radius = 9 mm
- electron-beam radius = 6 mm
- cathode radius = 20 mm
- focusing magnetic field = 68 mT

When injector current is boosted to 65 kV (design value), output power exceeds 500 KW and gain is about the same, but efficiency drops to 55 percent.

Six figures, not reproduced, show the relationship between electrode shape and electron track; graphs of electron-beam phase and speed vs range Z; a plot of the magnetic field distribution; a photograph of the entire klystron; a plot of output power, efficiency, and gain vs injector voltage; and an oscilloscope plot of the output power waveform. There are no tables.

References: 4 Chinese, 3 English.

China: Developmental Strategy of Coal Cleaning Technology

963A0037A Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese 25 Nov 95 No 11, pp 1-4

[Article by Guo De, Heilongjiang Mining College, and Xia Zonggeng, Coal Dressing Planning Research Institute: "Strategy for the Development of Clean Coal Technology in China"]

[FBIS Translated Text] Since the 1980s, clean coal technology has come into its own to enable the effective use of coal resources, raise the efficiency of utilization of coal, and reduce the pollution of the atmosphere from coal combustion. At present, clean coal technology has already become a hot topic in the worldwide development of coal technology. In March 1994, the Ministry of Coal Industry established the Research Center for Clean Coal; clean coal technology has already been placed on the agenda of important items for the development of Coal technology in China.

I. The Necessity of Developing Chinese Clean Coal Technology

The phrase "clean coal" appeared in the context of the United States and Canada solving the problem of acid rain along their borders in the 1980s. Clean coal technology is a general term for the new technologies of coal extraction, processing, burning, conversion, and pollution control. From the clean coal technology that arose in the United States, it has attracted the general attention and respect of the international community.

Coal is an important component of primary energy resources. China is the world's largest producer and consumer of coal and is a country whose primary energy source is coal. In 1992, China's production of raw coal reached 1,114,600,000 tons, and her consumption reached 1,142,700,000 tons, about 24.4 percent of the world's total. Nearly all of 1993's 1.15 billion-ton production was consumed domestically. Coal has an extremely important position in China's economic development. In 1992, coal contributed 76 percent of our electricity, 75 percent of our industrial fuel and power, 80 percent of our civilian commodity energy resources, and 60 percent of our chemical industry's raw materials. Coal accounts for 76 percent of our consumption of primary energy resources. Based on the conditions of China's energy resources, it is predicted that for the next 30-50 years coal will still be our most important energy source.

Although coal has made a tremendous contribution to the development of the economies of China and the world, it brings a series of problems with it in its development and use. 1) The specific gravity of China's coal is low; the structure of its products does not meet the demands of coal-units, utilization efficiency is low, and waste is severe. 2) Atmospheric pollution created by the SO_2, CO_2, and ash produced from coal combustion. The amount of smoke and ash released is 141.4 million tons. In northern cities, the annual average daily value for TSP in the atmosphere is 403 $\mu g/m^3$, and 243 $\mu g/m^3$ for southern cities; the respective values for SO_2 are 97 $\mu g/m^3$ and 90 $\mu g/m^3$. In addition, the influence of exhausted CO_2 on atmospheric change has attracted the attention of neighboring and Pacific nations. 3) The methane released in the course of coal extraction creates pollution in the atmosphere. According to data calculations, China's annual emissions of methane from coal mines is greater than 6 billion cubic meters and the extracted unused high-density gas released into the atmosphere is above 120 million cubic meters. 3) The area in which the land surface subsides or is ruined due to coal extraction and on which dirt and gangue is deposited already amounts to 3.2 million hectares, and 22,000 hectares are added every year. Gangue accumulating at coal mines has reached over 1.6 billion tons, with 100 million added annually. Mine water pumped out of mines (highly mineralized, acidic, highly sestonic, and even containing radioactive elements) amounts to 1.75 billion tons, and 28 million tons of coal sludge is removed annually. 5) Because China's small rural mines are backward in extraction technology and equipment, the impact on the environment in the course of extraction and the burning of raw coal is great, and waste is severe. In sum. the trend of the times is toward developing clean coal technology in China, reducing pollution, conserving coal resources, and raising the efficiency of the use of coal.

II. Present Status of China's Development of Clean Coal Technology

1. Utilization Technology for Methane in Coal Beds

China's management of the absorbed methane in coal during the process of coal extraction is limited, so that when it is released into the atmosphere as coal is extracted, not only are resources wasted, but the environment is also polluted. Approximately 6 billion cubic meters of methane are stored in China's coal fields, approximately 29 percent of the nation's total and around 30 percent of the total release of methane from the world's coal beds. At present, domestic efficiency of extraction is about 15 percent; compared with the more advanced foreign level of 40 percent, there is great potential. The Coal Industry Ministry has already established a Coal Bed Gas Extraction Guidance Panel, as well as a Coal Bed Gas Information Center. The

Kailuan Mine Office is now carrying out a feasibility assessment, and according to the materials on the Tangshan Mine gas bed three bore holes could extract up to a projected 150 million square meters in a decade, with an extraction efficiency of up to 62 percent. This is truly an engineering project that turns a harm into a benefit and is full of promise. At the same time, the Development Planning Agency at the United Nations is using the global environmental fund to help China carry out a "Development of China's Coal Bed Gas Resources" project, now under way.

2. New Technology for Washing and Processing Coal

The washing of coal is the coal processing technology for applying physics, physical chemistry, chemistry, and microorganisms to remove ash from raw coal, reduce sulphur, and process it in order to achieve uniform quality, different uses, and appropriate grades; it is the most economical and effective route for the rational use of coal resources and the reduction of ash and sulphur dioxide emissions; it is the essential prerequisite for follow-up deep processing of coal and a universally recognized critical topic for research in clean coal technology. It directly impacts on the rational use of coal, in-depth processing, protection of the environment, conservation of energy, and transport conservation, as well as the economic, social, and environmental benefits of the coal production and coal utilization industries. Along with the development of clean coal technology, recent trends in China's coal washing are chiefly realized in two aspects: desulfurization and the sizing of ultra-low ash float coal and fine grain coal.

3. Molded Coal

The stipulations of the 1984 Environment Committee of the State Council policy on coal-smoke type atmospheric pollution control made molded coal a major route to controlling coal-smoke type atmospheric pollution. At present, the Mining College of China has already researched 18 types of successful special applications of molded coal technology, and 12 newly constructed trial plants will be put into model production. Industrial molded coal includes that used for boilers, molded coke, ferroalloys, chemical fertilizers, urban coalgas, calcium carbide, and locomotive-use molded coal, etc.; civilian-use molded coal includes common honeycomb coal and lighter honeycomb coal among the smokeless coals, etc.; special molded coal includes that used for direct reduction iron smelting (sponge iron), cooking, fireplaces, heaters, and fireproof materials.

4. Coal/Water Slurry Clean Coal Technology Systems (PWTC)

China's research into PWTC has already gradually advanced from theory to segmentation into units, realization in projects, and enlargement of scale. With the organization of the National Coal/Water Slurry Engineering Technology Research Center and the establishment of the Network for the Research and Development of Coal/Water Slurry Technology, a contingent has been formed that can undertake large-scale engineering technology research and development. The "Yanzhou-Japanese Coal/Water Slurry Co., Ltd.," established jointly between China and Japan, has already begun production with a 500,000-ton-per year output sent to Japan by ship; the fuel-oil furnace and associated projects to fire 230 tons per hour of coal/water slurry at the Shanxi Baiyang hydroelectric plant (150,000 kW) and project to expand slurry production at Shandong's No. 81 Coal Dressing Plant have already gotten under way; and the 250,000 t/a of the Beijing Coal/Water Slurry Demonstration Plant has already been examined and put into operation. In addition, China is separately working with Russia, Italy, and the United States to carry out coal/water slurry research that includes coal/water slurry pipeline transport.

5. Technology for the Comprehensive Utilization of Waste Rock in Coal

There is much mineral intergrowth among coal waste rock. To separate this mineral intergrowth or associated mineral growth out is also one important component of clean coal technology. Opening up cutting-edge industrial uses for coal mineral intergrowth is also an industrial task urgently awaiting development. The ash content of coal mineral intergrowth is generally lower than 76 percent and has a certain heat output capacity; developing waste rock combustion technology is also a topic that cannot be overlooked. One of these technologies is the low-grade coal fluidized-bed combustion technology developed at Zhejiang University.

6. Coal Gasification Integrated Circulating Technology (IGCC)

IGCC technology is an important technology to raise the total utilization efficiency of coal ash that has already attracted international attention. This industrial art is already employed in the "Sanlian Supply" gasification project at Shanghai's Wujing, and was activated in March 1990. In the first stage of the project it is planned to supply urban coal gas of 1.7 million m^3/a, carbinol of 200,000 t/a, and some extracted coal gas is for electric power plants.

7. Magnetofluid Generating Technology

Magnetofluid generating technology is a new type of generation in which coal ash is converted into gas and mixed with preheated oxygen-rich air and the thermal energy used directly to generate electricity. China has carried out over 30 years of research on this technology and in 1987 it became part of the national high-technology development plan (the 8-6-3 Plan). It is projected that within this century we will construct an experimental magnetofluid integrated circulating installation with a hot input capacity factor of 25 MW and carry out a long-term power generation and system test, preparing to be able to establish a demonstration power station and, together with the nations of the world, enter into the practical application stage in the beginning of the next century.

8. New Model Technology for Combustion and Removal of SO_2 and NO_x from Stacks

China's own technology of the combustion of boat-shaped coal particles can reduce NO_x emissions by 30 percent to 60 percent. Because China's environmental protection laws have not yet made any clear demands regarding NO_x emissions, this has not been deemed important by the power plants.

As for lowering SO_2 emissions, the most advanced technology is the stack lime shower method (wet method). Its efficiency in removing sulphur is generally above 90 percent; however, investment and operating costs are enormous. Specialists recognize that China should preferentially choose and burn low-sulphur coal, use calcium jets in furnaces, and augment wet technology; when burning mid- and high-sulphur coal, it should use dry emission cyclic sulphurization bed desulphurization technology and dry spray flue-gas desulphurization technology. Some experts also advocate reducing expenses by spraying appropriately fine lime particles into the upper part of the fire box and using the high humidity in a suitable part of the fire box to roast it into CaO powder, which, when it follows the flue gases into the cyclic sulphurization bed, will act as a catalyst to remove sulphur.

9. Coal Liquefaction Technology

Coal liquefaction is divided into direct and indirect liquefaction technologies. In China, research into direct liquefaction was reestablished in 1980. Its goal is to produce superior quality light- and middle-grade transport fuel and aromatic hydrocarbon chemical industry stocks. Experiments at the Beijing Coal Chemistry Institute show that some of China's gas coal and lignite can be used for coal liquefaction; the bituminous coal of Beisu, Tengzhou, and Tianzhu and the lignite of Shenbei and Xianfeng are ideal for coal liquefaction: their oil productivity is high and their hydrogen utilization ration is high, too. Tests indicate that when the carbon content is 80-85 percent, the H/C atomic ratio is greater than 0.8, the volatile portion is greater than 40 percent, the activated constituents are greater than 90 percent, and the ash content is less than 9 percent in washed float coal or raw coal, they will have relatively good liquefaction qualities. At present, China plans to use technology from the HRI Company of the United States to build a demonstration plant in Silinhot that will handle 100,000 tons of coal per year to prepare for making it more widespread.

Indirect liquefaction technology research is being undertaken by the Shanxi Coal Chemistry Institute. They have already developed a new MFT synthetic gasoline technology, with successful results in intermediate experiments. At present, they are setting about doing an industrial test of 2,000 tons per annum to form a basis for establishing a model plant.

10. Subterranean Coal Gasification Technology

On the basis of lessons learned from the experience of the former Soviet Union, the United States, Britain, Germany, etc., we have selected the new technology of large cross-section, long-tunnel, two-stage gasification and have achieved high thermal value water gas (12.6 MJ/m^3) in the laboratory. The Xinhe Mine of the Xuzhou Mining Bureau is now carrying on industrial tests. If these are successful, it will convert the traditional physical coal extraction industrial art into chemical coal extraction industrial art.

To sum up, China has already achieved remarkable results in clean coal technology, eliciting the respect of the international energy resource world. Of course, there are several areas in which there remains a considerable gap between China and the rest of the world.

III. Strategy for Developing China's Clean Coal Technology

By developing clean coal technology in China, we can vastly reduce the release of pollutants into the atmosphere, greatly raise the utilization and economic efficiencies of coal, and promote the diversification of our energy sources; this is an important path for conserving coal resources. Therefore, clean coal is the future of our energy resources. However, our country is in the process of development and lacks capital and technology. Thus, for a certain period of time we have to distinguish between the primary and secondary with regard to new technologies that have already been set for development. On the basis of the characteristics of clean coal technology in combination with concrete conditions

in China, the basic agenda for developing our clean coal technology is as follows:

1. **Aim:** To increase benefits, reduce pollution, and encourage development.

2. **Goal:** To develop economical, effective, practical new technologies to realize environmental protection, conservation of energy resources, total utilization of resources, and reduction in pollution from the development and use of coal; to offer technological support to coal enterprises to change their single-product structure and to make up deficiencies and increase surpluses.

3. **Principles:** (1) under the premise of increasing efficiency, reduce pollution, unify the environment and development, and give equal importance to social or environmental benefits and economic benefits; (2) high efficiency, conservation of energy, and pollution control must run throughout the entire process of coal development and use; (3) we must aim at diverse coal consumption structures and, on the basis of efficient clean utilization of coal, develop multilevel advanced practical technology for different customers and actively promote existing mature technology while researching, developing, and importing economical, effective, and practical technologies; (4) with the development of clean coal technology as the turning point, change China's single-product coal structure and raise economic benefits. The end-point users will be chiefly electric power and industrial furnaces.

4. **Development Sequence:** After a general assessment of four indices—characteristics of the environment, the rate of energy conservation, maturity, and the economic nature—the sequence for the development of China's clean coal technology is:

(1) Industrial or Near-industrial Technology

1) **Coal Dressing.** Coal dressing is the prerequisite for the rational use of coal, the most economical way to reduce release of pollutants into the atmosphere, and the most realistic route. 2) Molded Coal. In the next 20 years, the civilian and industrial demand for this will be great. 3) Coal/Water Slurry. An oil substitute whose technology is basically mature and environmentally sound. 4) Advanced Combustion Vessels. This is an economical and feasible technology for reducing NO_x emissions.

(2) Technologies Under Development

1) **Constant Pressure Cyclical Fluid Bed Combustion.** Combustion efficiency is high and it is environmentally sound. 2) Gasification. One of the leading clean coal technologies. 3) Coal Gas Integrated Circulating Power Generation. The future technology of choice for coal combustion electricity generation. 4) Coal Liquefaction. In areas rich in coal and poor in petroleum, conditions for commercialization are already present. 5) Desulphurization of flue gas. Revolving atomizing dry roast absorption is the desulphurization technology that fits the conditions of China.

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China: Medium- and Long-Term Development Strategy of Electric Power

963A0037B Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese 25 Nov 95 No 11, pp 10-12, 26

[Article by Wu Zhonghu, Energy Resources Research Institute, State Planning Commission: "Medium- and Long-Term Strategy and Measures for the Development of Electric Power in China"]

[FBIS Translated Text]

I. The Present State of Development and Reform

The long-continuing power shortage that most areas of the country experienced beginning in the early 1970s was replaced upon entering the 1980s with a lively development of the electric power industry arising from the nation's adoption of a series of structural, investment, value, and property tax reforms with regard to the electric power industry, establishing the strategies of "saving is the substance, government and enterprise are separate, link up the electricity network, unify dispatching, and collect capital to produce electricity" and "stipulate what works according to the network and the location." The annual increase in electric generating installed capacity has already increased from the 4 to 5 million kilowatts of the early 1980s to the 12 to 15 million kilowatts of the early 1990s. The per capita installed capacity of 67 watts in 1980 has reached 165 watts in 1994. This has contributed a huge power source for the rapid development of the economy of the people and progress in promoting industrialization. From 1991 to 1994, China's economy developed at the rapid rate of an average 11.7 percent per year; the power generation capacity increased at a slightly slower rate of 9.98 percent, but a serious nationwide energy shortage did not appear.

There has been a relatively great rise in the electric power elasticity coefficient since the 0.64 of the period of the "Sixth 5-Year Plan." In 1991-1993, it reached 0.91.

The national unit proportion of fixed asset investment in the electric power industry went from 7.12 percent in 1981 up to 8.2 percent in 1993, and had reached 12.8 percent in 1990.

Reforms in the financial investment system and the electric power management system broke the state electricity monopoly and the unified collection and disbursement of the fiscal administration, the method of depending on state allocated unitary capital sources to develop the electric power industry. Encouraging the accumulation of capital to undertake electricity and the use of foreign capital, as well as putting into practice a multiple electricity pricing system, brought about the appearance of many investment bodies and broadened the channels of investment. In 1980, the 66.3 percent of basic construction funds that were accounted for by funding within the state budget was down to only 3.8 percent in 1993. Moreover, the "two-cent" funding for power construction and the funding from the power bureau and raised locally have already risen from the 28 percent during the "Seventh 5-Year Plan" to 50 percent. As for the use of foreign capital, it has dropped to 6.1 percent from 9.6 percent. Bank loans have risen greatly in amount, from 13.8 percent to 33.3 percent.

The management of the electric power industry is now moving from monopolistic management to a state-managed power network (with the state granting powers to state power enterprises), and the multiple undertaking of power plants has given rise to independent power plants under local, entrepreneurial (as with Huaneng), bureau, individual foreign investment, and domestic-foreign joint investment or cooperative construction management.

Implementation of the multiple power pricing system has meant, with regard to independent power plants set up with domestic and foreign investment and local, foreign-funded, and non-Electric Power Bureau plants, a power pricing policy of return of capital and interest with a reasonable profit, thereby creating for the management and operation of independent power plants the conditions that will allow them to accumulate capital for expanding further production.

II. Problems

1. Local imbalances in power and temporary power shortages are still severe. Even though the scale of investment in electric power grows year by year, the ongoing rapid development of the economy, upgrading of industrial structures and modernization of technical equipment in the course of industrialization, the ever-rising demands made on electric power with the rise in the people's standard of living, and especially the increase in electricity use for urban government and life, have caused the peaks and valleys in the power network to be ever more disparate and brought about a drop in load power. Limited power establishment investments cannot satisfy the need for increases in power generating equipment. The economically developed coastal areas in the southeast, such as the provinces or cities of Guangdong, Shandong, Fujian, and Shanghai, as well as the power regions where hydroelectric power is proportionately more significant, such as Hubei and Sichuan, are subject to the effect of water availability; adding in the restrictions of coal transport for thermal generation of electricity, and the problems of insufficient electric power availability become very evident.

2. In some electricity-poor areas along the coast and in the interior, the development of diesel oil power generation and small-boiler power is most injurious to the rational utilization of resources. According to statistics, in 1990-1993, for units greater than 6,000 kW, small-boiler power lower than 50,000 kW increased at an average annual rate of 6.5 percent, from 18.68 million kW to 22.58 million kW; of the net increase over 3 years of 3.9 million kW, 85 percent was in middle or low pressure units. During the same period, the proportion of units greater than 200,000 kW went up to 51 percent from 44 percent, but their function of saving energy and reducing consumption was erased by the small-boiler sector, and the 3-year consumption of coal for power generation only dropped 8 grams per kilogram, less than 3 grams per kilogram per year, a huge disparity with the goal of a decrease in coal consumption between 1990 and the year 2000 of 50 grams per kilogram, 5 grams per kilogram per year.

The reason why small-boiler electricity has not achieved "replacing the small with the big" but instead has developed rapidly is directly relative to power shortages, but after the multiple sourcing of power investment and the decentralization of policy making on investment, in a situation where control and approval of the scale of investment for large- and mid-size type projects is difficult and slow, the motivation of local interest plays a large role.

3. Heavy power source construction and light power network construction. Because large amounts of investment from capital accumulation, autonomous fund raising, and foreign capital are used for the development of power sources, and the funds in the state budget are insufficient while the construction and management of the power network is the responsibility of state-owned

units, the construction of power networks is very sluggish. The problems are even greater especially with the failure of construction funding to materialize for urban networks and rural power networks.

Concurrently, some localities have established many power development organizations to develop local power but, whether because of breakdowns in negotiating fees for getting on the network or because of being lead by self-interest, they have constructed networks in power districts where large networks already provide power, resulting in a great waste of construction resources.

4. The development of the electric power industry, in view of the shortfall in funds and lack of equipment, needs to expand the scale on which it utilizes foreign investment. Available international financial institution's government grants, and export credits are already very limited. It is necessary to make use of direct investment by foreign firms, and foreign capital does look favorably on the Chinese power market. However, there has been more talk than success on medium- and large-scale projects, the major obstacles being guarantees, repayment rates, electricity pricing, and repatriation of foreign funds, so most successes have been with small-scale projects, such as small fuel oil, gas generated, and small thermal power.

5. Systematic deficiencies and the split between bureau and local interests have caused the joint coal-power ventures and large-scale joint thermal power generation projects that would fit national industrial policy to move forward at a slow pace. The multiple difficulties even have the effect of making it hard to receive the benefits of projects already set up.

III. Strategies and Measures

According to the development targets for the economy, the GNP will maintain an 8-9 percent growth rate in 1996-2000 and 7-8 percent in 2001-2010; in order for the electric power industry to maintain development in coordination with that rate and a balance between supply and demand, installed generating capacity should reach 285 to 300 million kW in 2000 and about 500 million kW in 2010. In 1994 installed generating capacity was 199 million kW; from 1995 to 2000, the annual increase must be 15-17 million kW, and from 2001 co 2010 there must be new additions of about 20 million kW. The required power investment is huge. Comparing the present maximum capability of funding channels with the projected requirements for funding, the gap is large-about one-third. The ability to make generating equipment is also insufficient, especially in the case of plants above 300,000 kW.

For the future development of the electric power industry, the strategy chosen should be to broaden further the channels for financial investment while regularizing investment and making it more stable; installation of electric power should resolutely take the path of large capacity and a high parameter of technical equipment, gradually reducing and eliminating small boiler installations and actively developing hydroelectric, nuclear, wind, and gas-steam integrated circuit power plants, and encouraging and supporting coal-electric joint operations and thermal-power joint production projects. Strengthening the construction of power networks, reforming and perfecting urban and rural networks.

The measures that should be adopted to realize these strategies are as follows:

1. Establish and perfect funding mechanisms for electric power to further expand and stabilize funding sources. (1) Under the present electric power investment structure, state funding is lower and lower—only 3.8 percent in 1993, which shows a large discrepancy in comparison with the fixed asset investment ratio of 7-8 percent or more for the electric power industry within state-owned units. We propose that state investment in electricity be raised to the same ratio. The measures for this would be to establish a state foundation for the development of electric power. Capital sources: one is to reallocate part or most of the loans that have been given to state-owned electric enterprises to be converted into enterprise capital funds, with interest reinvested in the fund; a second is to collect two or three cents per kilowatt hour on top of the price of the electricity to become a national fund for the development of electric power; a third is the income from floating electric power bonds abroad and domestically. To accomplish this, we must set up a special institution to run and manage the development of the foundation. (2) Speed up electric power pricing reform. We propose completing a new pricing structure in 1997 to replace the present multiple power pricing system. The new price system will be carried out under a structure of returning capital, paying interest, and making a reasonable profit to raise the ability of state-owned electric enterprises to autonomously accumulate capital and broaden the ratio of funds raised on their own. At present, the funds raised by localities and the power bureau occupy 25.4 percent of power construction funding, out of which 25 percent is funding from the electric power bureau and Huaneng, and the greater proportion is capital raised locally. The funding sources and channels are very unstable. We project that once we have price reform and strengthened management, raising the ability of electric enterprises to raise funds on their own, its proportion of the electric power investment will rise to 30-35 percent. Power price reform will also raise

the competitiveness of power bonds and stocks. Raise money for more electric power construction funds.

2. There must be major progress in the use of foreign capital for power enterprises. Projecting a capital shortfall by the end of the century of approximately one-third, use of foreign capital must rise to 25 percent; under present policies, reaching this goal is very difficult. If we envisage raising it from the present amount shy of 10 percent to 15-20 percent, a corresponding set of policies is needed before we can break through the impasse in foreign capital utilization. The authors feel that future use of foreign capital by the power industry should continue to be primarily indirect, supplemented by direct use. At present the indirect use of foreign capital by the power industry occupies about 10 percent of the national total and this should not be lowered in the future, especially when it must be used on state projects for medium and large power generation and the construction of large networks. In accordance with the special characteristics of construction and operation in the power industry, international commercial loans must be treated with caution and we must use them sparingly while at the same time strengthening management and exercise strict oversight. As for direct foreign investment, because of the guarantees, the rate of return, and issues of pricing and remittance, it has developed slowly and requires adjustments in policies. In actuality, guarantees, the rate of return, and issues of pricing are interrelated; the level of rate of return is not only a matter of economic factors, but is also a matter of an understanding of political risks and the level of trust. In the use of foreign capital, aside from strengthening public relations work to enable foreign business to understand China's situation and political and economic systems, in regard to the rate of return we must adopt a flexible policy, not trying to "cut everything with a single knife," and can adopt different measures based on the locality as well as the importance and progressiveness of the project. For example, it can be a little lower in economically developed areas, it can be a little higher in the interior areas, and it can be a little higher for medium-scale hydroelectric projects, not only giving domestic and foreign investors room for negotiation on projects, but also bringing into play the guidance of investment direction. For the sake of broad-visioned adjustments, on the basis of the post-appraisal analysis of certain projects and the foreign and domestic finance conditions as well as the special situation of the power industry, we can project a range of rates of return to be selected for projects and the corresponding regulations for conditions, that will be promulgated by the State Council to improve the transparency of foreign capital utilization. Concerning remittance of foreign exchange, the state should also make a clear model document for promulgation to enable foreign commercial interests to find a legal basis for remission.

3. Measures proposed to deal with problems in developing power courses and weaknesses in the construction of power networks. (1) Besides going further in strengthening production policies and administrative intervention, we should strengthen project examination to deal with the facts that most capital comes from the localities and decision making is scattered. For those districts where there is definitely stable thermal load and coal resources are sufficient, besides permitting the construction of small thermal plants, we should halt the construction of small boiler plants of less than 50,000 kW across the board. Small thermal plants should possess qualifications for getting onto the network, and based on the principle of taking into account the interests of all sides, the power network bureau should permit them to get on the network to sell power, and when projects are up for approval, they should come with a letter of understanding (or a contract) for getting onto the network to sell power as a condition for being reviewed for approval. We have to take stock of small boiler plants already installed and create conditions under which they can get on the network in accordance with the requirements of the power bureau; those who meet the requirements cannot be refused permission from the bureau to sell power on the network. At the same time, we shall reform the management and operation modes of power plants and develop competition in the generation segment so that among plants getting on the network there will be competition in the price and cost of power getting on the network, so high-consumption low-efficiency small boiler plants will lose their competitiveness and be eliminated gradually. In order to guard against local protectionism and avoid redundant construction of power networks, the power to approve the construction of power transmission lines should be appropriately recovered at the higher levels. (2) For the innovativeness of power enterprises under a modern enterprise system and their reorganization as companies and businesslike management, we must select appropriate provincial power companies and structure new productive frameworks and management modes in order to absorb capital from all quarters, concentrate funding, plan comprehensively, and construct power sources according to principles of rational distribution and beneficial scope. (3) The construction of trunk networks shall be by a state network company using primarily state funds for construction and operation. Distribution networks must be independently run, acting as the retail enterprises of power companies; their profits should be capable of giving them the ability to restructure and perfect the distribution network. (4) Break up the bureau, splitting it up into pieces, organizing an independent coal power company and thermal power

company to take responsibility for establishing and running large-scale coal and thermal projects; stipulate a set of policies to encourage their development to enable them to have a reasonable profit and attain a lively development.

China: State Level Electric Company To Be Established

963A0019A Beijing RENMIN RIBAO in Chinese 27 Dec 95 p 1

[Article by Jiang Shijie: "State Level Electric Company to Be Established—Major Strides Made in the Structural Reform of the Ministry of the Power Industry"]

[FBIS Translated Text] 26 December telegram of this paper from Beijing. The reporter Jiang Shijie learned at National Electric Power Working Conference held today in Beijing that the Ministry of the Power Industry which serves as an experimental unit for institutional reforms by the State Council will be reorganized into a State Level Electric Company based on a decision by the State Council. This will be done to set in motion the major reforms of the structure of China's electric power industry as well as its electric power industry enterprise system, and accelerate the pace of transformation from a planned economy to a market economy structure.

The Minister of the Ministry of the Power Industry said at the Conference: the core of the structural reform of the electric power industry is the separation of the functions of government from those of enterprises, that is, beginning with the break up of the functions of the Ministry of the Power Industry, clearly demarcate the responsibilities of the government, enterprises and trade associations. Necessary government functions will be separately transferred to composite economic administrative departments, the functions connected with the enterprises will be transferred to the State Level Electric Company which is planned for establishment, and the functions of the trade administration will be transferred to the Chinese Federation of Electric Power Enterprises.

The newly established State Level Electric Company is authorized by the State Council to exercise the rights of a state investment principal and state owner, and the management of government assets within an authorized range. Its three basic responsibilities are: one is the owner representative of the central government electric power assets as authorized by the State Council; two is the investment and administrative principal of central government assets; three is the management of transregional power transmission economic entities and the central administration of state electric networks. The State Level Electric Company and its affiliated electric power enterprises will form an electric power enterprise administrative system made up of companies with centrally coordinated operations, management at different levels, and which accord with the modern enterprise system, and which take assets operations and production dispatching as major links. This requires the establishment of parent subsidiary relationships at each level so as to form an electric power industry enterprise system of the State Level Electric Company: group companies, provincial electric power companies, independent legal power plants (companies) and power supply enterprises. The State Level Electric Company is the contributor of investments of central government assets of various group companies or independent provincial companies; the group companies and independent provincial companies are subsidiary companies of the State Level Electric Company. Group companies are also investment contributors of various provincial companies in groups; provincial companies are then subsidiary companies of group companies. The power companies of independent legal entities are limited liability companies or joint limited stock companies set up by various investment contributors, and group companies or provincial power companies are the representatives of contributors of central investments. The State Level Electric Company may also, based on need and willingness of the enterprise, accept electric power companies not affiliated with the Ministry of Power Industry, set up necessary interconnections, and the separation of the functions of government from those of enterprises will be maintained.

China: State Oil, Gas Development and Exploration Key Laboratory Established

963A0019B Chengdu SICHUAN RIBAO in Chinese 3 Nov 95 p 1

[Article by Liu Qian: "The Key State Laboratory of the 'Oil-Gas Reservoir Geological and Development Project Passes Inspection"]

[FBIS Translated Text] China's only key State laboratory in the field of oil and gas development and exploration—the "Oil-Gas Reservoir Geological and Development Project" passed State inspection in Sichuan on 31 October.

This laboratory is a sub-project of the "Key Disciplines Development Project" set up with a loan from the World Bank. It began to be established in 1991 on the basis of two state key disciplines of coal field and oil-gas geological and exploration and oil-gas field development projects of the Chengdu College of Science and Engineering and Southwestern College of Petroleum, and its main direction of research and responsibilities are the "searching for, identifying, developing, protecting, and transforming" of oil and gas beds, guaranteeing high

stable production, and raising the recovery rate of oil and gas. The Directorship of the Laboratory and the Directorship of the Academic Committee are held by Luo Pingya, academician of the Chinese Academy of Engineering, and Liu Baojun, academician of the Chinese Academy of Sciences respectively.

During the last 4 years, the Laboratory has utilized loans from the World Bank, domestic supporting funds, capital construction and scientific research funds, aid funds from the United Nations and government of Canada to establish and improve 12 laboratories so as to form an integrated strategic organization with multidisciplinary cross permeation and superior complementation. The instruments and equipment of the Laboratory possess the advanced levels of the 1990s. According to statistics, during the last 4 years, the Laboratory has undertaken and completed a total of 280 scientific research projects, and among these, 112 were at the national level, 132 were at the provincial level, and 84 projects won scientific research achievement awards. Among these, six projects were at the national level, and 78 were at the provincial level; there were patent applications made for nine projects; 44 monographs were published; 343 papers were delivered both domestically and abroad; and 87 doctoral students, 404 master's students, and eight postdoctors were trained.

With authorization from the Ministry of Geology and Mineral Resources and the (National Petroleum) Corporation, a committee of nine specialists including Zhang Zonggu, an academician of the Chinese Academy of Sciences and Chinese Academy of Engineering who served as the director as well as Ou-yang Ziyuan, Liu Baojun, and Xu Xi, all academicians of the Chinese Academy of Sciences, carried out the inspection and acceptance of the key state laboratory, the "Oil-Gas Reservoir Geological and Development Project" in Chengdu and Nanchong from 28-31 October.

China: Strategy of Using Foreign Capital in Power Industry

963A0038A Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese 25 Sep 95 pp 16-20, 5

[Article by Gui Heng [2710 5899]]

[FBIS Translated Text] The electric power industry has had over 10 years of experience in using foreign funds, and it has been very successful in doing that, but in the last 7 years of this century $25 billion will be needed to develop the electric power industry and it will be even more difficult to draw in foreign funds to make up the shortfall of 200 billion yuan and 45,000MW in power equipment. International financial markets follow the international political scene today, and the economic scene is in a turmoil of change and moving in several new directions. Because of historical conditions and a different background China can't continue to use foreign funds indiscriminately the way some countries have successfully used foreign funds to develop their economies. The new international investment situation is a major concern for China's electric power industry in using foreign funds. Examination and study of the use of foreign funds by the electric power industry has to be based on the current international financial market situation and China's national conditions combined with the realities and special characteristics of China's electric power industry.

I. The regulation of international policies and the use of foreign funds by the electric power industry

From 1979 to 1993, the electric power industry made use of approximately $13.73 billion, which was 11 percent of the total investment in electric power construction, and 25 percent of the total domestic installed capacity is newly installed capacity. The foreign loans and financing that were used were mainly in the forms of government loans, World Bank and industrial bank loans, international commercial loans, and export credit from foreign countries, and those forms made up 81 percent of the total of all foreign funds. The electric power projects built with borrowed funds were all quite successful, and the electric power industry must continue to use foreign funds wisely in the future.

1. The use of foreign government loans for electric power projects will gradually disappear

In February 1992, the member nations of the Organization for Economic Cooperation and Development (OECD) signed an agreement in Helsinki stipulating that government loans by OECD nations to developing nations could not be used for inflating national power or advantage, and electric power was included in that. There will be a big drop in foreign government loans for the electric power industry hereafter, the only exception being possibly projects concerned with environmental protection. In the past 13 years that the electric power industry has been using foreign funds, over $4 billion has come from government loans, the largest share of the total of foreign funds used. Losing that will be a big challenge for the power industry. The power industry is a finance intensive industry, its projects cost a lot of money and investment returns are long term. It is a basic public welfare industry, and can't take big profits, its sales earnings are state revenues, and therefore the most suitable form of foreign funding is foreign government loans and loans from international financial

organizations with long-term repayment and preferential conditions. South Korea, for example, used a large amount of foreign government loans in the process of developing its electric power industry. Under the conditions of recent history, China's electric power industry simply can't go that route, and can only look for other suitable ways to go.

2. Use international financial organization loans as much as possible, and expand joint financing for projects

With foreign government loans now being limited, getting loans from international financial organizations has to be the means of funding electric power projects, mainly through the World Bank and industrial banks.

The World Bank has assisted 13 electric power projects financially since 1981, 5 of which were thermal power plants, 7 were hydropower stations, and one was a power transmission project, supplying a total of $2.5 billion. The World Bank changed its loan policy for electric power departments in December 1992, and that may cut back on general loans for basic electric power construction, and increase loans for raising the operational efficiency of power transmission and for assisting environmental protection; and it will want countries requesting loans to show real progress in many policy reform areas, such as turning power departments into enterprises, making management conform to general international commercial practices, strengthening the clarity and continuity of policy decisions, formulating rational policies for the price of electricity, and introducing a competitive market mechanism. China's economic organizational structure reforms are not in conflict with the loan policy changes made by the World Bank. For the next 5 to 8 years, World Bank loans to China's electric power industry will continue to be in the range of $500 to $800 million. The World Bank will enhance financing of Chinese electric power projects through adoption of enlarged joint financing measures that will be helpful in speeding up the supply of private funds and extending the time limits on loans. That way, the World Bank can make a loan to the electric power industry each year for one hydropower and one thermal power project. In submitting requests to the World Bank the electric power departments will want to choose large-scale hydropower projects or those large in scale with relatively large units, and thermal power projects that meet environmental protection requirements.

Industrial banks can also make loans to China's electric power industry each year on the order of $200 million on conditions similar to those of the World Bank, and the Japanese foreign assistance fund can also provide loans of $500 to $600 million. It will be difficult to increase the scale of loans from international financial organizations for electric power projects, which are basically fixed, and they fall well short of the foreign funding amounts that the power industry needs.

3. Increase the use and range of export credits to counter the effect of constricted foreign government loans for electric power projects

The rate of interest on export credit is quite low, generally lower than the financial market interest rate for similar conditions, the difference being made up by the loaning governments, and it has a matching complementary component which makes it a rather favorable loan. The primary object is to support and expand exportation of that country's facilities and make them more competitive internationally.

The international market competition for exporting equipment is fierce, and the world equipment market is very aware that China is in great need of power industry facilities. The time is ripe for China to take advantage of the fight for China's market that is going on among advanced western countries by batch importation of large assemblies of power generating equipment, which lowers import prices, while at the same time asking the exporting government to raise and broaden the range of its export credits. Many foreign governments are eager to raise their export credits; for example, the U.S. has lost out in the competition for exporting equipment to some Asian countries because it did not raise its government preferred loans and export credits. The U.S. has announced that hereafter it will also offer preferential loans to boost its exports. China must make full use of export credits to counter the limits put on government loans.

4. Make appropriate use of international commercial loans

In order to make up for the shortage of preferential loans it will become increasingly necessary to make use of international commercial loans. International commercial loans have rather high interest rates, time limits of 10 years or less, and carry certain risks, but there is a lot of loose change in international financial markets and it is available for loans. All that is needed is good loan credit reliability and the means to make repayment, and a lot of money can be had. Now that China is better able to get foreign exchange through exports, and has a lot of foreign exchange in reserve, and is in a much stronger position overall, the electric power industry could properly make more use of international commercial loans and borrow enough money for financing projects to make up for the shortage.

II. The direct international investment situation and direct foreign commercial investments for electric power projects

In the early 1950s, indirect investment was the mainstay of international capital activity, and by the 1980s, with the advance of internationalized production and management and free trade moving farther and wider, direct international investment had become the most important and most active element in international economic life, even more important than international trade. Direct International investment has become an increasingly important function in the world's economic development, especially for economically developing nations. In keeping with the trends and effects of the direct international investment situation, the electric power industry is going to have to go both ways and get direct foreign commercial investments as well as official foreign-government financing.

1. The direct international investment picture

Although there are many ways to get direct international investment, the main providers are still the multi-national corporations of advanced western countries. In 1992 and 1993, multi-national corporation investments and foreign investments were respectively, $148 billion and $167 billion, which accounted for 86.5 percent and 85.6 percent of all direct investments made in those years throughout the world. They are the main direct international investors.

According to analysis, direct international investments continued to grow rapidly in the 1990s, increasing at a rate of about 8 percent per year, several times the growth rate of international trade. The growth rate to developing nations was over 10 percent. By 2020, global direct foreign investments will be up to $800 billion, half of which will be absorbed by developing nations.

The Asian-Pacific area is the most active and promising investment field in the world today, and it is one of the central areas getting assistance from the World Bank and other international financial organizations and western governments. China is right in the middle of those rapidly developing Asian-Pacific economies, and the market strategy for global economic development is turning the multi-national corporations toward China as the focal point for their investments. Since 1993, a number of internationally-known multi-national corporations have come to invest in the Chinese area and set up representative organizations, and China has picked up half of that total.

2. The primary motives for direct foreign investment into developing nations

The primary goal for direct foreign commercial investments is the long-range pursuit of a share of the market and maximum profits. Foreign investors in the multi-national management field concentrate on investment strategies, and they go after long-range benefits for the corporation, such as the multi-national corporations of well-off western nations, which have an entirely global market-seeking strategy, and their activity is not entirely about getting a real percentile advantage from the host country, but their emphasis is on certain products and changes and trends in their share of the market, and the active position of their competitor's. A lot of multi-national corporations and major foreign corporations investing in the Chinese area are getting a long-range foothold for a cooperative strategy to join in the advance of Chinese modernization and make forward-looking investments. The Chinese market today is no longer a closed and independent market, but it is an important part of the international market.

3. Prospects for direct foreign investment for development of the electric power industry

Through many years of reform, China's economy has entered a period of continuous, steady, and rapid growth, and near the end of this century The growth rate of the GDP will be above 9 percent. The mid- and long-range forecast is that China's economic growth rate will continue to be above that of western industrial nations. There have been great changes in the form of the economic organizational system, the intensity of economic development is on the international track, the legal system improves daily, economic activity is gradually gaining a legal structure, the socialist market organizational system will gradually be established, the substance of China's investment environment is greatly improved, and its market potential is hugely attractive to foreign investment. Since 1993, the confidence expressed by U.S. commercial interests in China's 5-year projected investment environment went up 18 percentage points over 1992, and 98 percent of all U.S. enterprises asked, considered China to be the most ideal investment location. The domestic economy has built an environment that is favorable for direct foreign commercial investment.

China's electric power industry has more than 10 years of experience in using foreign financing, and there have been qualitative changes in the investment structure. The situation has changed from mainly borrowing foreign funds to more and more direct foreign investment and electric power joint-stock corporations of foreign commercial investors have appeared on the scene. Direct

investment has also changed being solely from Hong Kong sources to joint sources, including advanced western countries in league with Hong Kong, and investment locations have also changed from coastal areas, which continue to be key investment sites, to the hinterlands, which are attracting foreign funds at growing rates. Foreign funds are being used in many and better ways now. These are indications that the electric power industry is entering a prolonged period of attracting foreign funds, and it is estimated that direct foreign commercial investment will really take off before long.

4. Getting financing and raising the capability to manufacture electric power equipment in concert with the diversity of strategies and motives of foreign commercial investors

(1) Using direct investments from multi-national corporations and large foreign corporations that are out to maximize profits.

Technologically and financially intensive electric power projects require huge investments, and China's goal is to bring in foreign funds for direct purchases of equipment. It only takes one or more multi-national corporations or large foreign corporations to provide such large sums, and because their home investment markets are dwindling, and many lucrative investment departments are already saturated, in order for them to multiply their global management, they are very willing to invest in projects that are not aimed at making profits from the primary industrial products; projects such as the Chinese electric power industry. At the same time, because their domestic monopolies are complete and the competitive mechanism is already there, electric power corporations in advanced countries also look upon electric power markets abroad as a future development strategy.

The electric power product sales market is readily saturated, it is a market that opens up a crack and then closes up again, and it is often bound by national characteristics and can't become a large unified world market like many industrial products have, and there is no globally competitive product market. That's why China can use the "trade the market for funds" approach. Foreign corporations invest in China's electric power market for profits , and they want maximum profits. But, the electric power industry is a basic industry in the public welfare domain, and there is no hope for high returns, taking high profits is impermissible, and China can't promise a high rate of return on big investments to attract foreign funds; it simply won't do. It can't be gotten out of the price of electricity, and foreign commercial people understand that point. What they look for in financing China's electric power projects is stable income and low investment risk; and where there is suitable investment repayment capability, there will be investments. What investors are most concerned about in making such large direct foreign commercial investments into electric power projects is the security of their investments. There are a number of major multi-national corporations that have been in contact with the relevant Chinese departments with the intention of investing in electric power projects, but they have yet to make substantive investments, and it isn't entirely because the investment repayment rate is low, it is mainly the investment environment, which they see as being still too risky. Only a few small-scale investments in projects with quick returns are made as trial investments made for the purpose of getting to know China's investment environment. Hong Kong investors are more familiar with the mainland, and they have many years of practical experience with small projects in Guangdong, and in the late 1980s and early 1990s, some large Hong Kong investment corporations got into the Guangdong electric power investment market, and they have gradually pushed inland. China has to do all it can, starting with improving the investment environment, to get more direct foreign commercial investments for electric power projects.

(2) Make use of the foreign international group product market share strategy, and build a Chinese-foreign jointly managed electric power equipment production base

There is an electric power shortage around the world amounting to some 60,000MW and 25 percent of that is in China. To start with an existing installed capacity of 180,000MW, and have a rapid annual growth rate of 8 percent has never been done before by any other country, and that huge demand for electric power equipment will be matched by new growth in the market position for electric power equipment on the international market. China presently has 3 large power generator factories, and they are ill equipped to meet such a large demand, though the Dongfang electrical equipment factory did fulfil its 300MW generator mission for 1997 by April 1994. The international group enterprises that manufacture electric power generating equipment are particularly interested in China, the most promising electric power market in the world, and hoping to get even bigger share in supplying the Chinese generator equipment market, they will put the product market share strategy up front. There are a lot of limitations in trying to depend on exports alone to make their products competitive against other multi-national corporation's products. This being the case, they will want to come to China to invest in building factories and setting up electric power production bases.

China's electric power industry now has a line of 200MW thermal power generators, and although it has only about 10-years of experience in the factory, it has over 30 years of technological experience, and some of its 300MW-unit technology is out of date. If the average efficiency level of China's power plants were raised 10 percent, that would amount to a new installed capacity increase of 18,000MW, which is more than the new units going into operation in one year, an obvious benefit. If China's manufacturing technology for electric power equipment can't catch up, then it will have to depend mainly on imports, and that will provide reliable and cheap electric power, which will help China's industrial products be competitive on the international market. China should latch on to the enterprises of international multi-national groups that want to build power equipment export bases abroad, and based on principles of mutual advantage, attract them to come to China to invest. Trade the market for technology, build China's electric power equipment production base through cooperative joint ventures, import advanced foreign production technology and management experience, fill the domestic gaps, and in the end the national industrialization of electric power equipment that China needs will be there, and it will create the conditions for solving the energy shortage, and then set out for long-range targets, for developing an outward looking economy and expanding China's share of the market for electric power equipment, and that will be good for solving part of the foreign exchange imbalance question.

III. Select and make prudent use of international securities as a means of raising money

China's electric power industry has been using foreign funds very effectively for more than 10 years, and has reached the growth stage where it is primarily an absorber of industrial capital financing, but it is just a beginner when it comes to using the modern financing tool of bond investments for international financing, just at a time when the international financing market is in a state of great change. The international financing market is developing rapidly, and with securities exchange financing it occupies an absolute proportion of the international capital market. Therefore, the electric power industry must expand step by step into the new stage of absorbing the capital investments of international financial securities, and has to explore how to use the bond market to raise foreign funds.

1. The trend toward raising bonds in the international financial market

As international trade surges forward, the world economy is heading toward regionalized and unified development, and economic linkage between countries is getting stronger and stronger. There is great change in the international investment structure, and international bond investment is the new kid on the block, and those in quest of financing are issuing bonds and stocks more and more, and raising money directly from the public. In order to adapt to the development of international investment, the bond market has broken through the physical and man-made limitations, and is constantly expanding the range of financing. International bond financing has eclipsed international loans and has become the dominant form of international financing.

2. Very little of the Chinese bond market is internationalized

The Chinese bond market was established only recently, and the legal system and laws and regulations are adolescent, its movement is irregular, and it has a low degree of internationalization, and although a B stock exchange has been set up to attract foreign funds, whatever its range or international character, it is a long way from being an international bond market. There are also some limitations on foreign investment in the domestic A stock market. The electric power industry can't attract foreign financing through the domestic bond market.

3. Get beyond the domestic bond market and go directly into the foreign markets

Today, the international financial market situation offers excellent opportunities, interest rates are low, and although in recent years there has been an increasing demand for funds and there is more competition for it, and that makes it more difficult to raise money through bonds, the opportunities are still there; once lost, they do not return. But the degree of internationalization of the domestic bond market is too low, and establishing an excellent bond market and forming a socialist market mechanism is not done in one single step. It is a slow-growth process, and the electric power industry, which has urgent need of foreign capital, has to flow with the tide and plunge into the international bond market. Time waits for no man. Electric power enterprises must go beyond the domestic bond market, and in accordance with international practices, go directly into the international bond market, seize the great opportunity provided by domestic economic reform, incorporate and change the stock system, take the initiative and enter the international capital market, adopt the various effective forms and means for issuing stocks and bonds abroad, and really go after foreign financing.

4. Establish a Chinese-foreign cooperative common fund, and change project financing into industrial financing

Although a good number of Chinese enterprises of various forms are already in foreign markets, the Shandong Huaneng being the first state enterprise to go directly into the U.S. market successfully, there are not a lot of electric power enterprises that can do so short term. The domestic economy in its present form and circumstances makes it difficult for any electric power enterprize to get into foreign markets or issue bonds on any scale in a short time frame. They can only go one at a time when conditions are ripe and borrow small amounts of foreign financing. The electric power industry has to choose the bond financing tools that conform to their actual situation.

The profitability and mobility of Investment funds are clearly better than banks; they guide reserves toward investments, are more advanced and modern, beyond the capabilities of traditional commercial banks, and they play an important role in the torrid scene of international bond financing. According to World Bank estimates, world funds have holdings of $14 trillion, and the typical investment fund structure is the common fund. The international practice of attracting foreign funds through a common fund format has been very successful, and it is widely used by new industrialized nations, such as Singapore and South Korea, and it is an especially suitable way to get investments for China's electric power industry.

Electric power projects are finance intensive, and in the eyes of foreign investors, only large financial groups or international corporations have the means to make direct investments. Smaller investors are left in the dust. Although foreign stocks meet the investment requirements of small and moderate investors, it is very hard for China's electric power enterprises to get into the market on a large scale any time soon. By means of an investment fund, with the fund managers using their special credentials to study the situation, managing investments, spreading out investment risks, saving on the cost of investment, and raising the effectiveness of investments, then that will enable small and moderate investors to make better returns on their investments. There is an abundance of small and moderate investors, and collectively they are a force that can meet the large sums needed for electric power projects. Successful promotion of an investment fund will open up another important foreign financing avenue for electric power projects.

In organizing an electric power investment fund along the lines of a modern investment fund, the idea is to adopt an open model that will be in harmony with development trends of international investment funds and the investment habits of foreigners and that will be beneficial for getting into a foreign market. Establishing an investment fund isn't just for financing certain specific electric power projects or a form of project financing, but for getting industrial financing for the whole electric power industry, and although special beneficial projects can't be dispensed with, what is of primary importance is reputable management of an investment fund, and what is more needed than special beneficial projects is to get it into a foreign market appropriate with the present stage of historical conditions. A common investment fund can be started up cooperatively between a major foreign fund structure and China, managed as a common fund. Once the money is in place, and the organizational management entity establishes a reputation, it can then apply to be listed on the domestic or a overseas stock market to raise funds. At that point it only needs to bring its fund management entity up to the requirements for getting in a foreign market, then it can hang out its shingle, and that way every electric power project won't have to be conditioned for market entry. Only one fund management entity has to get on the market to raise funds for a great many electric power projects, and keep it all proper to the present state of national conditions. The easy way to get on a market is for the fund management entity to get a domestic registration. Hong Kong can be the basic registration, or register in a western country. choose a suitable method and route to get on a market, such as going to the U.S. and getting an ADR. When the foundation gets on a market, the fund financing capital will snowball, and a foreign investor can get an appropriate rate of repayment, and issue fund bonds on a foreign capital market. The fund wants to get investments for its investments, and it only needs to get on a bond market to sell its useable stocks and bonds.

Electric power projects have low investment risk, which, besides being suitable for a common fund, makes them suitable for foreign insurance companies, retirement funds, and other sound investment companies to make direct investments in China. The electric power industry must actively create conditions for an investment fund that will attract large sums, be highly competitive, have long-range fixed interest rates, and participate in China's electric power construction.

China: Hydropower Development Strategy in Investment, Financing for Energy

963A0034A Beijing SHUILI FADIAN [WATER POWER] in Chinese 12 Jan 96 No 1, pp 6-8

[Article by Ma Haibin [7456 3189 3453]—Investment Research Institute of the People's Construction Bank of China, Beijing, 100810]

[FBIS Translated Text] **Abstract.** China's constricted energy supply is at odds with the rapid pace of economic development, and the many problematical ramifications that arise from that demand that deep research and investigations be made into both investment in energy resources and development of energy resources taken together as one strategic issue. Studying the theory and practice of energy resource investment in China, and probing the objective laws and management methodologies in the financing and the development of energy resources, will help them to better serve China's rapidly developing economy. It will mutually benefit their strengths and have great significance for people in the energy and financial worlds to link up their common interests and combine their research into the questions of energy resource development and investment.

Keywords: Hydropower construction; Energy; Investment; Development

Development of energy resources was given a very prominent position in the (Recommendations) of the 5th Plenary Session of the 14th CPC. The necessary research problems in energy finance are: China energy resource development plans and strategy for the "Ninth 5-Year Plan" and long-range targets for the year 2010; adjustment and improvement of the internal structure of the energy industry; questions concerning the contradictions in the balance of energy distribution and economic development; feasibility studies for building the San Xi (Shanxi, Shaanxi, and eastern Inner Mongolia) coal base, the southwest hydropower base, and the southeast coastal nuclear base; organizational structure for financing and development of energy; research on investments, price structure, tax revenues, and credit policies for energy development; research on practical conservation and utilization of energy resources; research on development and utilization of new energy sources; domestic and international energy market research; and research on development and protection systems for precious petroleum and coal resources. More research power should be put into these questions as quickly as possible and results obtained for the needs of China's economic development.

1. Adjusting the energy development structure, and setting a strategy for preferential development of hydropower.

In view of the realities of China's economic development, it is not only going to take more investment to resolve energy "bottlenecks," but the structure has to be adjusted to get a rational investment scale for the development of thermal power, hydropower, coal and nuclear power and even solar, water, geothermal, wind power, and bio-energy. A scientific development strategy also has to be defined. Because coal power is hampered by the location of coal resources, and transportation and environmental pollution factors, it is difficult to realize much growth in scale there, and large-scale development and utilization of wind and solar power, which are limited by objective factors, are yet to come. Therefore, considering the present energy resource development patterns and the natural resource picture, the time has come for major development of hydropower.

1.1 China's wealth of hydropower resources are ripe for development.

China's hydropower resources can be developed to produce 37.8 million mW, highest in the world, and the average annual output could be 1.92 trillion kWh, 2.3 times the total of all electric power produced today. But, only 10 percent of it has been developed, well below the world average. From a strategic point of view, hydropower development is one of the basic means by which China's electric power crunch can be resolved.

1.2 Hydropower development has major political, economic, and environmental significance.

Water is clean, renewable energy, and leaving it undeveloped is like throwing away large amounts of gold and silver every day. Developing hydropower means saving large amounts of precious coal, reducing atmospheric pollution from power generation by thermal power, cutting power generation costs, and gaining the comprehensive benefits of flood prevention, irrigation, transportation, livestock breeding, and tourism. Yunnan, Guizhou, Sichuan and Tibet are hydropower resource-rich areas where economically backward minorities are concentrated, and hydropower development will bring economic development to those areas, which will have the great benefits of further bonding the people and maintaining social order. When hydropower is fully developed it will provide cheap electric power for economic development which will lower the costs of products from various industries, expand production, effectively increase provisions for society, and hold down inflation.

1.3 Enhance existing hydropower development.

Hydropower should be developed small, medium and large scale simultaneously, and the State should give key status to construction of large and medium-sized hydropower stations. In the past China was unable to build high-cost large-scale hydropower stations that took a long time to build, but today, China has a lot more financial strength than it had in the early reconstruction period, and it can properly reduce investments in other industries, and it can double the pace of hydropower development by increasing investments in hydropower by over 2 billion per year through various channels. China now has hydropower design and engineering capability to spare, steel and concrete in stock, experience in large-scale hydropower stations such as Gezhouba, and frankly, the manpower, materials, financial strength, and technology are all there to set the conditions for large-scale development of hydropower.

The southwest has 71.1 percent of all the hydropower resources in China. Hydropower resources abound and conditions are good at Dadu He, Lancang Jiang, Jinsha Jiang, Yalong Jiang, Wu Jiang, Nanpan Jiang, and Hongshui He, and they should be the key locations for development. In 1994, a Southwest Hydropower Development Symposium sponsored by 5 organizations, including the Sichuan Province Electric Power Bureau, Southern Power Joint Management Corporation, and the Construction Bank, was attended by over 40 units from the Ministry of Electric Power, State Planning Commission, and the People's Bank, etc., and more than 80 experts and high-level managers attended, who all agreed unanimously that development of southwestern hydropower should be accelerated.

2. Implementing a policy that gives equal weight to energy resource development and energy conservation.

The solution to the energy problem depends on development first, and then energy conservation. The conservation of energy doesn't just mean saving precious non-renewable petroleum and coal resources, it is also about increasing the total volume of energy resources, and that is a point of strategy that has to be driven home. Energy conservation is reflected in the quality of the people's economy and the level of S&T development. Advanced countries are very conscious of energy conservation, such as in Germany where energy conservation is a consideration from the design and construction of buildings to the research-manufacture of architectural materials, both closely watched and tightly regulated. There is a lot of energy wasted in China where energy consumption per unit of gross value of output is 3 times higher than in Japan and double that of India, and it is 30 to 90 percent higher than the per-product energy consumption level of advanced countries in the early 1980s. Advanced countries have concentrated heating units, while heating by boiler is still a common practice in China. Prospecting for coal, oil, minerals, and natural gas are frequently done in separate redundant efforts, and linked up with small power plants, small generators, coal transportation, and coal washing, it is all inefficient and wasteful, and among them lies a huge potential for energy conservation. By using existing energy resource production capabilities and relying on S&T advances to lower the per-product consumption of energy consumption to the level of advanced countries, it will be possible to double the economy.

Wind, solar, and tidal energies are renewable energy resources that should be further researched and developed. They can be made renewable and can save precious non-renewable petroleum and coal resources, and raw materials for the chemical industry.

Some coal pits operated by collective and privately owned units are mindlessly plundered, damaging resources, and create problems for the management of coal businesses and that should be corrected through policy measures.

Too little attention was paid to energy conservation in the past and it didn't get the manpower and financial backing it needed, nor the programs and policies. There is now the "Energy Conservation Law" which has been approved and passed by the State Council and delivered to the NPC for examination and approval. Effective study and propagation of energy conservation laws and regulations, improved conservation consciousness of all the people, and increased application of conservation S&T, will raise the conservation effort in China to a new level.

3. Greater financing for energy resources must be done and can be done.

The great shortage of electricity for the people's productivity and livelihood results from China's large population, retarded energy development, and energy supply constraints. In 1994, the amount of electric power produced by China was 920 billion kWh, 2nd largest in the world, and yet that was only 767 kWh per person, only 40 percent of the world average, ranking 80th in all the world. More than 20 percent of the country is without electric power, including 28 counties and 120 million people. This amounts to great economic losses, direct losses in state revenues of up to several 100 billion yuan, and several tens of billions in financial losses. The reality is that on the one hand there is a serious lack of electric power, and on the other there

are the worlds 3rd largest coal reserves, and especially the world's greatest hydropower resources which have not been well developed. It's not hard to see that the basic cause for this situation is insufficient investment. It is the general rule of economic development throughout the world that in the process of industrialization a country will invest over 2 percent of its GNP into electric power, and in the period from 1980 to 1992 China invested only 1.24 percent of its GNP, and from 1979 to 1992, China's GNP grew 9 percent annually, while electric power growth was 8 percent annually, and that shows that increased financing for energy to resolve the serious imbalance of supply and demand not only must be done, but it can be done.

3.1 China is growing stronger and has the economic muscle to increase financing for energy.

In 1994, the GDP reached 4.380 trillion yuan, and investment in energy by national units was 4.7 percent of the GDP, and if the effort is made to reduce redundant construction and non-key investments by 1 percent per year, and increase financing by about 2 billion, it can be done and that will reverse the state of affairs in energy supply in China.

3.2 Investments in energy earns high returns, has no market risks, and finds enthusiasm in all quarters.

The shortcomings of China's energy resources have been around a long time and they are the product of the quick sell, not market risks. Although initially investments were quite large, follow-up financing for energy, compared with other industrial targets, has been considerably less, and a lot of the unneeded floating capital for shop fixtures was used for unnecessary equipment replacements and for the development and research-manufacturing of products. Energy benefits are stable and secure, and every 100 yuan of energy investment gets a higher rate of return than it does in many other industries and departments. That is why enthusiasm is high everywhere for developing energy, and that is why the rate of increase in foreign investments for energy goes up every year.

3.3 With supporting policies and diffuse sources it will not be difficult to raise energy development funds.

Among the means of raising money are: (1) Proceeding from the overall economic development situation and under a situation where costs and benefits are kept to limits all can bear, the price structure of energy products could be adjusted in steady steps, and that would enable energy resources to accumulate and develop on their own. When the price of crude oil was raised in 1994, it reversed a succession of losses by the oil industry that had gone on since 1988, and profits were transferred on up to the higher authorities. (2) Have a favorable credit policy. For example, State development banks and national commercial banks could support energy through preferential loans at appropriately low rates of interest and financial discounts. (3) Reduce taxes on energy and set separate tax reductions according to the development requirements of petroleum, coal and power interests in the energy industry. (4) Lower the capital funds rate for large-scale hydropower projects, and raise the capability for responsibility accordingly. For example, the capital funds rate could be fixed at 3.33 percent (the (Ba Ji Er) agreement stipulates the capital figure at 4 percent) because the security of hydropower capital is higher than financial capital. (5) Open up new avenues for raising funds for developing energy resources. A fixed ratio could be extracted from the profits that energy businesses transfer to higher authorities; and integrated with the conservation effort, certain amounts could be taken for over-standard use of electricity, extravagant hotel dinners, and other non-productive uses by power-consuming elements to support construction of key energy projects. (6) Guarantee government investments and issuing of sufficient volumes of stocks to raise the capital funds needed for energy development. (7) Link up the capital funds of energy development corporations and issue proportionate guaranteed-compensation bonds. (8) The local people and small-town enterprises and other power-consuming elements could be mobilized to raise money for small-scale energy projects which require small investment and give fast returns, and engineering units could buy shares in construction and materials and get credit support from banks as means to raise money. (9) Make active use of foreign funds through Chinese-foreign joint ventures and the BOT, international financial organizations, foreign government and commercial bank loans. Issue energy investment stocks and bonds to foreign interests. However, prudent consideration must be given to the ability to make repayment and the economic stability of development before using foreign funds.

China: Coordinated Development of Water Resources in Xijiang River

963A0034B Beijing SHUILI FADIAN [WATER POWER] in Chinese 12 Jan 96 No 1, pp 30-34

[Article by Chen Renying [7115 0088 5391]—Zhu Jiang Water Conservancy Commission Design Academy, Guangzhou, 510611]

[FBIS Translated Text] **Abstract.** The Xi Jiang water system of the Zhu Jiang river basin is rich in water resources, and while it has superb navigation conditions, it is also a serious flood threat. In respect of the

development of its water resources, there are among its hydropower, river navigation and water conservancy activities objective conflicts and inevitable inherent linkages that demand that all factors be considered under a unified plan for their coordinated development.

Present plans and designs for the development of the mainstream of the Xi Jiang call for its hydropower development to be well coordinated with the development of navigation, power generation and flood prevention, and for the conflicts between water resources development and the economic development of the reservoir zone to be to resolved in order to have a rational development and management of the Xi Jiang, and that then will help the development of the river to proceed more quickly and more smoothly.

Key words: Xi Jiang water system; hydropower; water navigation; water conservancy; coordinated development; Unified planning taking all things into account

1. Summary

The Xi Jiang water system makes up the main body of the Zhu Jiang water system. Since the 1980s, a great amount of research has been done by relevant departments on the comprehensive utilization of their water resources and to find ways to remove the conflicts that arise among them, and that has resulted in the creation of The Hongshui He comprehensive utilization plan, Zhu Jiang basin comprehensive utilization plan, and the Zhu Jiang basin navigation plan, all of which have passed State examination and approval, and they will be the bases for future development and management. The planning has progressed rapidly and has been very successful, but the development and utilization of water resources, in the overall view, is still low and rife with problems and inter-departmental conflicts that require further coordination and more skillful handling.

The Xi Jiang basin is rich in water resources, there being, theoretically, a reserve of 29,430MW for an annual average output of 257.8 billion kWh, and installed capacity of 21,340MW (of individual stations with 500 kW installed capacity or greater that are already built or planned based on the reconnaissance surveys done in the 1970s) for an annual average output of 99.3 billion kWh. According to statistical data reworked in late 1992, 25,800MW of installed capacity (single stations of 500 kW or more installed capacity) could be developed for an average annual output of 119 billion kWh. By the end of 1994, power stations totalling 4,300MW of installed capacity had been built and were generating an annual average of 18.8 billion kWh of electricity, leaving 80 percent of potential hydropower resources unused. Most of the hydropower stations now built are run-off stations lacking adjustability, which much reduces their scale of output during dry seasons, and they lack peak adjustability in their electric power systems.

There is an abundance of water in the Xi Jiang water system, the river courses are steady, there is little sand, it doesn't freeze up in the winter, navigation conditions are good year-round, the mainstream and primary tributaries provide water transportation throughout south China and the southwest. It is the golden waterway of the south. Most of the navigation channels are still in their natural conditions, and very few have been raised by engineering methods. There are some stream segments have not come under total unified planning for development and utilization, and the navigation courses are obstructed by dams, gates and bridges. Navigation standards are degraded in some places for lack unified management or inferior maintenance. Only 2,525 kilometers (km) of primary and tributary navigation courses have navigation standards of 100-ton class or above, 648 km of which are 1,000-ton class, 138 km are 500-ton class, 351 are 300-ton class, and 352 km are 100-ton class. For a variety of reasons, the volume of water transportation on the Xi Jiang is losing its place year by year against the total volume of transportation nationwide.

Water conservancy construction on the Xi Jiang has a long history, and especially since liberation, many reservoirs, dikes, water gates, and water diversion and lifting structures have been built. Structures on the lower reaches are generally built to 5-year flood level standards, some to 10-year standards, and the whole basin area of 466,700 hm^2 is readily inundated, 65 percent of which is under preliminary management, and up to 2.1287 million hm^2 of area is being effectively irrigated, or 62.2 percent of the total tilled land in the basin (based on statistical data of 1990). The success of the water conservancy effort is evident, but the degree of developmental management is not high, there are as yet no bulwark reservoirs for holding back flood waters, and the dike standards are low; The degree of flood management is low, depending mainly on water gates to direct free running water, and very little water is pumped by mechanical or electrical means. The proportion of irrigated arable land is not high, 1.3333 million hm^2 of tilled land is not equipped for irrigation, and another 1.4 million hm^2 of land that could be readily farmed lies idle.

2. Analysis of existing conflicts in the development of water resources

As the economy develops rapidly, various departments and business are becoming more and more interested in the development and utilization of water resources, and day by day conflicts arise among them, primarily

with respect to their conflicting hydropower, water transportation and water conservancy interests.

2.1 The conflict between development of hydropower and development of navigation

The Xi Jiang has a wealth of water power resources and it also has very good conditions for navigation, and the proper thing to do for the people's economic and social development is to develop and make use of the hydropower resources and accelerate the development of navigation activity, and while on a single stretch of river they have their commonalities, they also are in conflict with each other. The conflicts are mainly manifested in the following ways.

2.1.1 Damming up rivers for hydropower development hinders navigation by boats. Locks and boat-lifts have to be built for boats to get through and that increases the cost of engineering. The building of structures for navigation raised the total investment figure for the Dateng Xia water concervancy hub by 12 percent, and for the Dujiang Baise water concervancy hub it was 15 percent. During construction, navigation activity was even more burdened with delays. One trip through the locks now takes about 1 hour.

2.1.2 Discharge volumes differ for peak adjustments and daily operational adjustments at a hydropower station making the downstream flow very uneven, and that affects normal navigation. Often counter-adjustment reservoirs have to be built downstream. Without the benefit of comprehensive use of counter-adjustment reservoirs, the project financing will be greatly increased. The Xi Jiang water system will have hydropower stations with peak adjustment services, and counter-adjustment reservoirs will be evenly arranged downstream. Naji, downstream from the Dujiang Baise water conservancy hub, and Banzhai, downstream from the Liujiang Rongjiang hub, are both counter-adjustment reservoirs. On the Hongshui He, the Dahua hub provides the counter-adjustment for the Yantan hub, and the Yantan hub serves as a counter-adjustment for the Longtan hub. Even with counter-adjustment reservoirs there still are conflicts between a power station peak adjustment and navigation that should be further corrected and resolved properly. The volume of discharge from a power station can't be less than minimum flow volume for through navigation; there can only be a base load volume, thereby lowering the peak adjustment benefit of the power station. For example, at the Dateng Xia hydropower station, to guarantee a minimum discharge flow volume of 700 m3/s, the maximum peak adjustment output is reduced to 200MW.

2.1.3 When the water at a power station with an adjustable reservoir gets so low that the former natural conditions of the river course before the reservoir was built reappear at the aft end of the reservoir, the navigation channel will be cut off. In order to get around this, the dead-water level is raised, which reduces the effective capacity of the reservoir and cuts down on the benefits of adjustability. In order to link up the Baise reservoir with the Wacun cascade navigation channel, the dead-water level was raised from 195 meters to 203 meters, reducing the adjustable capacity of the reservoir by 560 million cubic meters, and the annual average discharge volume increased from 1.7 percent to 3.3 percent, and diminished power output during dry seasons cut the annual average output by 75 million kWh.

2.1.4 There is not much sand in the Xi Jiang water system, but the tail end of the reservoir can still silt up with mud and sand, forming new shoals that hinder navigation during dry periods. The new flow conditions can change the original stability of the river bed downstream from the power station, which further affects navigation, necessitating dredging and other methods to correct that.

2.2 Conflicts between power generation and flood prevention

Flood prevention is the first order of business for water conservancy departments managing the development of the Xi Jiang. In order to master the flood-prevention problems of the entire river basin, besides the flood-prevention engineering aspects of repairing dikes, dredging channels, and safely managing the primary river outflow volumes at the river mouth, what also have to be included in the flood prevention mission are reservoirs, which are the obvious means for controlling flood waters in the basin by adjusting, storing, and discharging volumes of water according to the particularities of Xi Jiang flood waters. The flood prevention capacity of reservoirs have to be raised sufficiently before the arrival of a flood period, ready to hold back the flood waters until the flood period ends. The water head for power generation at such a station will be lowered in flood periods, and water will be discharged, which will cut back the power output. Anticipated flood water retention capacity is in conflict with power production efficiency, and it is especially true of power stations where there is a big difference between the flood retention capacity and power efficiency capacity. For example, the Baise reservoir, without its flood prevention mission, would be unequalled in Guangxi for its large-scale multi-year adjustment operations, but because its flood-prevention standard has been raised to benefit Nanning during the flood season (May to August), 1 million cubic meters of its 2.6 million cubic-

meter power-efficiency capacity goes for flood prevention, and because of the higher dead-water level needed for navigation, the Baise reservoir cannot serve entirely as a multi-year adjustable reservoir.

In a situation where flood prevention is so important, and there is a shortage of power-efficiency capacity, then flood-water retention capacity should not come out of the power generation capacity, and further flood-prevention capacity should be built above normal water storage levels, or part of the reservoir capacity should be used both ways. This would reduce the conflict between power generation and flood prevention, but it would increase the scale of engineering.

In addition, river retention dikes built for power generation targets ought to have sufficient scale of flood discharge, otherwise it can reduce the water-carrying section of the river course, which does not make for a good flood way.

2.3 The conflict between water resources development and economic development in the reservoir zone

River retention dams (or gates) that store water and raise the water level for power generation, diverting water for irrigation, or flooding shoal hazards for navigation channels, all cause inundation damage in the reservoir area. When the area that is inundated and the area that benefits are administrated differently quite serious conflicts can arise, as in the case of the Longtan reservoir on the mainstream of the Xi Jiang, much of its reservoir lies within Guizhou and the power station is in Guangxi; the Dujiang Baise reservoir zone is in Yunnan and the hydropower station is in Guangxi; and Guangdong is the main benefactor of flood prevention from the Dateng Xia reservoir, which is located in Guangxi, and if these conflicts are not skillfully handled it is difficult to get construction going.

The economically developed middle and lower reaches of the Xi Jiang pressed for raising navigation standards and developing hydropower, and river-retaining dams and gates were built for that purpose creating a streamway type of reservoir that could maintain the flooded area around the project, but after the water level was raised, both banks were flooded to no good purpose and the original free water diversion gates were no longer useable, and as a result, effective ways had to be found to raise the technology level of water diversion.

3. Coordination for the comprehensive development of the water resources of the mainstream of the Xi Jiang

The upper to lower reaches of the Xi Jiang are called, respectively, Nanpan Jiang, Hongshui He, Qian Jiang, Xun Jiang, and Xi Jiang, and from the mouth of the Huangni He on the lower reaches of the Nanpan Jiang to Gaoyao on the Xi Jiang segment is the main section of the Xi Jiang mainstream. It traverses Yunnan, Guizhou, Guangxi and Guangdong, a full length of 1,367 kilometers, 62 percent of which is the mainstream of the Xi Jiang. Researched by relevant departments and approved on high, the water resources development policy will be: The upper reaches from the mouth of the Huangni He to Dateng Xia will be "totally for comprehensive use with all things considered, for power generation primarily, and also for the benefits of flood prevention, navigation, irrigation, and water products." The lower reaches from Dateng Xia to Gaoyao will be "primarily for navigation, and also for hydropower development, and for satisfying the needs of flood prevention, irrigation and protection; and for further development and comprehensive use of water resources." The trans-boundary Dateng Xia water concervancy hub will have "equal importance for flood prevention, power generation, and navigation, and all other things considered."

According to the above policy, there will be 12 cascades: Tianshengqiao 1st-and 2nd-cascade, Pingban, Longtan, Yantan, Dahua, Bailongtan, Qiaogong, Dateng Xia, Changzhou and Longwan. [xltr's note: apparently Etan was left out, but as to where it fits in, there is no clue.] When finished their total installed capacity could reach 13,730MW with an annual output of 62.8 billion kWh. Hazardous rapids at over 200 locations downstream from Leigongtan will be submerged, creating an excellent navigation channel approximately 200 kilometers long. The Longtan and Dateng Xia reservoirs will adjust for floods in combo, and that could effectively control the Xi Jiang on a 100-year flood-cycle standard. The Datengxia reservoir will provide free-flow irrigation for the 31,346 hm^2 of cultivated land around Guiping, Guixian, and Pingnan, and electric pumping for irrigation will be reduced over an area of 66,700 hm^2 in the reservoir zone. After the main cascade stations are built, there will be enough electric power to pump water for the irrigation of 38,700 hm^2 of agricultural land on both banks of the Xun Jiang and Xi Jiang, which will raise the agricultural irrigation standard there. Comprehensive development of water resources can change the environment and be good for development of the tourist industry and the social and economic development of the area.

Of the 12 cascades on the main segment of the Xi Jiang mainstream, Dahua, Etan, Yantan, and Tianshengqiao 2nd-cascade have been built and are generating power. Tianshengqiao 1st-cascade and Bailongtan are under construction, and preparations for construction are underway at Longtan. The coordinated development of the water resources is going well, but there are some irregularities between the situation as it unfolds and the research findings of the relevant departments that are under discussion and will be further studied.

3.1 Coordination between hydropower and water navigation

The mainstream of the Xi Jiang connects the southwest with south China, and it is an important waterway for transportation to the outside, and it is strategically very important to the economic development of the Xi Jiang basin. The plan is to raise the navigation standards and link up the bodies of water between the cascades, and except for below the Dateng Xia dam, they all have varying degrees of water head. To satisfy the requirement to have them channelized, the upstream portion from Laibin will have a 4th class navigation standard and the portion below Laibin can meet the 3rd class navigation standard requirement. When all cascades are finished, each downstream cascade will serve as a counter-adjustment reservoir for the cascade station upstream, and this way the effect of power station peak adjustment on downstream navigation will be avoided or reduced.

When the cascades are finished each reservoir will pretty much have an excellent deep navigation channel, but in using the adjustable reservoirs at Longtan, Yantan, and Dateng Xia for transportation, the water drops a lot, and during dry seasons the channel depth at the aft end of the reservoirs can get to be shallow, lowering the navigation standard, but the upstream reservoirs can be relied on to supply water volume to help out. The Longtan reservoir, for example, can have over 1,000 cubic meters of flow volume, which is over 5 times the dry-season flow volume before construction of the reservoir.

From Tianshengqiao to Nagong is the famous Leigongtan, which has a natural drop of 183.8 meters, and the Tianshengqiao 2nd-cascade power station gets its water through a tunnel, and because the Leigong river segment is not navigable, the factories from Leigongtan downstream to Nagong will transship by land around the Nagong to Tianshengqiao 1st-cascade reservoir zone.

To reduce losses from inundation, the Changzhou cascade on the lower reaches will use a normal water reserve level of 20.6 meters, and that can't be linked up with the 23.6 meter water level of Dateng Xia dam, which makes it difficult to satisfy the 3rd-class navigation standard requirement for the 12-kilometer river segment from Dateng Xia to the mouth of the Du Jiang. The following measures appropriate for the solution might be considered: (1) Increase the minimum discharge from the Dateng Xia power station to raise the water level downstream from the dam to 24.6 meters, reducing the peak adjustment benefit to raise the navigation standard; (2) Administer dredging to bring the river segment up to the 3rd-class navigation standard. (3) If possible, open up the Ganwang channel navigation line (the entrance to Ganwang channel comes ahead of the Dateng Xia power station dam, and return to the Xi Jiang mainstream at the mouth of Dahuang Jiang 42 kilometers downstream from Dateng Xia), and if the Ganwang channel can be built up to 3rd-class navigation standard, it will still be possible of avoid the effect of the Dateng Xia power station peak adjustment on navigation and get the full benefit of peak adjustment from Dateng Xia station; and navigation structures could be built in phases at the dam to satisfy both the near- and long-term navigation scale requirements.

As to the conflict between power station at peak adjustment and transportation, when a power station is at peak adjustment, downstream flow is unsteady, and the transportation departments want the water level in navigation channels to change not more than 1.5 meters daily, and not more than 0.3 meters per hour, and the flow speed to be not more than 3 meters per second. According to analysis of peak adjustment calculations of some Xi Jiang mainstream power stations, even with counter-adjustment reservoirs, for certain lengths of river segment below dams it is still difficult to satisfy the 3-point navigation requirement, especially the water level change requirement. For example, during a 15-hour peak adjustment at Dateng Xia power plant with a maximum output is 900MW, even if the downstream counter-adjustment reservoir level is raised to 24.6 meters, at the end of the 11-kilometer river segment below the dam, the water level will still change 2.8 meters daily, 1.0 meters hourly, and the maximum flow speed will be 0.67 m/s. In the channels that have been completely channelized, if there are no harbor piers built there, for a certain river segment in the tail water of the power station, flow speed will be the main factor affecting navigation in unstable flow in the downstream segment at peak adjustment, and the rate of water level change will be less important. Controlling speed is important for navigation safety. The conflict between power station peak adjustment and the

navigation requirement restricting flow speed to 3 m/s on the Xi Jiang mainstream can be coordinated without notable detriment to either side.

3.2 Coordination between power generation and flood prevention

There are two reservoirs on the mainstream of the Xi Jiang with flood prevention missions: the Longtan and the Dateng Xia. The power stations on these 2 hubs are large-scale stations, and according to the plan they will be important for coordinating the conflict between power generation and flood prevention.

3.2.1 The Longtan reservoir was designed to have a normal water storage level of 400 meters, and during flood season it would be limited to 385 meters. Its flood prevention capacity is 7 billion cubic meters, and diverting flood waters as a single reservoir it can raise the flood prevention standard for Wuzhou on the lower reaches from a 20-year cycle to a 50-year cycle. The 7 million cubic meter flood prevention capacity is 34 percent of the effective capacity of the power station, and when the water level is dropped 15 meters in flood season, that is 25 percent of the total working water depth, which reduces the water head for power generation 11 percent. There will be a definite loss of hydro-energy in favor of flood prevention in the flood season, but the power-generation benefit will not be measurably reduced. When the water head is reduced in the flood season, the generators will not be affected because the power generation head is still higher than the designed water head. The Longtan reservoir is a large multi-year adjustable reservoir, and its effective reservoir capacity will be cut back whenever there is a flood period, which will generally be in June and July. According to the 30-year hydrological data statistics, from 1951 to 1981 there were 90 flood periods (May to July), and in only 5 months were the run off volumes small; and because of the differences in hydrological characteristics between upper reaches and the lower reaches, the flood-prevention areas on the lower reaches will generally want the Longtan reservoir to hold back flood waters early in those months, June and July, and after mid July reserves can again be resumed. Subsequent to the holding of flood-prevention reservoir capacity as anticipated, the post flood-season run off for any year will usually be sufficient to replenish the reservoir, and the flow volume for adjustment and power output will not be reduced in the dry season. Because the Longtan reservoir has the favorable conditions mentioned above, it can closely integrate its flood prevention and power output according to design, and the power benefit will not be lost in favor of the flood prevention mission, nor will engineering costs need to be increased. But after that, it was agreed through discussions that in order to reduce losses due to inundation in the reservoir zone, the 400-meter normal water-storage level as designed, would be built to 375 meters, and in this way the reservoir capacity would be reduced by 11 billion cubic meters, which can only be adjusted annually. With the flood-prevention capacity thus reduced from 7 billion to 5 billion, the flood prevention standard on the lower reaches could only be raised from a 20-year cycle to a 40-year cycle. Questions concerning flood prevention on the middle and lower reaches rather came to a head in 1994 when flood waters exceeded the 40-year cycle, creating doubts about lowering the flood prevention standard. How to coordinate power generation and flood prevention once the Longtan reservoir's normal water retention level was lowered was a matter that needed further study to reach a proper solution. The key to the solution was to speed up construction in the reservoir zone for a proper resettlement of the people. The economy of the reservoir zone developed, the resettlement went well, and operations were able to proceed at the normal water level as designed, and the comprehensive benefits of flood prevention and power output were raised.

3.2.2 The Dateng Xia reservoir controls 60 percent of the area of the Xi Jiang upstream from Wuzhou. and it has a major flood-prevention function. The normal water retention level of the reservoir is 57.6 meters, limited to 53.6 meters at flood season, and the water-level control for flood regulation is about 65 meters. The corresponding flood-prevention capacity of the reservoir is 2 billion cubic meters, which, combined with Longtan's 7 billion cubic-meter flood-prevention capacity raises the downstream flood-prevent standard for general flood waters from a 20-year cycle to a 100-year cycle. The effective power-generation capacity is 467 million cubic meters, or 23 percent of the flood-prevention capacity. In order to raise the engineering benefit, and make more use of the flood-prevention capacity for power generation, the water level can be raised for power generation in dry seasons, adding to the common utility of the reservoir for both flood prevention and power generation, and increase the power benefit. According to long-term hydrological data on the Xi Jiang, major flooding does not occur from early August to late April of the next year, and the water level can be gradually raised after late October up to 61 meters. Initial calculations show that when uniting cascade operations, there can be a guaranteed output increase of 55mw, and 870 million kWh increase in annual power, an increased normal inundation of 1206.6 hm^2 of tilled land, and an average increase of 100 million kWh will inundate another 138.74 hm^2 of tilled land. When the water level is raised in the dry season there is a benefit

of reducing the water lifting height for irrigating over 60,000 hm² of farmland, and thereby lowering costs.

3.3 Coordinating losses from inundation in the reservoir zone

According to the plan, over 10,000 hm² of tilled land would be inundated and over 200,000 people resettled on the main river segment of the Xi Jiang mainstream. The development and utilization of water resources has to be done for the benefit of the local people's social and economic development in order for the development of the water resources to proceed smoothly. In the past, because the resettlement issue for some hydropower stations was not properly done, it led to some rather complex residual problems, such as the construction of the Xijin hydropower station in the 1960s where a large proportion of the people have not yet been moved and the only thing that could be done was to lower the normal operating water level, which has not only cut the electric power benefit, but also adversely affected access to the 1,000-ton class navigation standard between Nanning and Guangzhou soon to come.

In order to make up for the losses to inundation in the reservoir zone, resettlement of the people has to be well taken care of first, the policy of resettlement for development carried out, and the construction in the reservoir zone has to be done simultaneously or even ahead of the construction of the reservoir. The Xi Jiang river basin has excellent natural conditions, warm humid climate, and fertile soils that make it good for carrying out the resettlement and accelerating construction in the reservoir zone. The horticultural industry in the mountain areas is open to good development, and a comprehensive three-dimensional reservoir zone, mountain and water development can be had there.

Water resources development can spur the improvement of the local investment environment of an area, bringing in beneficial funds from the outside, and develop the economy, and create the conditions for arranging resettlement of the people, especially in the better developed areas on the middle and lower reaches. After the Dateng Xia and Changzhou reservoirs are built, outside funds can be used to develop the various kinds of resources in the reservoir zone, speeding up local economic construction, driving social development, and raising the living standard of the people in the reservoir area.

For the construction in the reservoir zone, besides the expenditures for resettlement, the locally flooded land should also be looked upon as a project investment and added to the benefit share, and part of the receipts from sale of electricity could be taken to support construction in the reservoir zone. Guangdong's investment in the Longtan hydropower plant was stipulated by agreement to be 15 percent. For 13 years after the 1st generator went into production, a 5 percent deduction from the price of electricity from the station based on cost was taken according to the volume of electricity that Guangdong actually got from the grid, and thereafter 20 percent was taken from the station price each year to be used to support the cost of economic development in the reservoir zone.

The area that benefits from the flood prevention should pay a year-round flood-prevention tax, a sufficient part of which should be used to compensate the temporary losses in the flooded area caused by flood water retention, and a part could be taken for development funds in the reservoir zone. For example, should the Dateng Xia reservoir experience 100-year cycle flood waters, the tilled land temporarily inundated for flood prevention would be as high as 27,000 hm², all inside the Guangxi boundary, and about three-fourths of the 27,000 hm² area of tilled land would benefit from the flood prevention would be inside the Guangdong boundary. The serious damages that would result in the area encroaching both provinces, if not properly worked out, would adversely effect the construction of the Dateng Xia reservoir, and it would be hard to prevent major flood disasters on the middle and lower reaches of the Xi Jiang.

3.4 Agreement on sharing engineering investments

The primary engineering endeavors for water-resources development on the mainstream of the Xi Jiang are all multi-purpose hub projects for comprehensive utilization for multiple benefactors, and in order to have unified planning that takes all things into account, it will often be necessary to broaden the scope of the engineering or add on engineering projects and increase the total of investments, and that means all departments that will benefit should share in the engineering investments for comprehensive utilization. In principle, the investments will be shared in proportion to the size of the benefit. The investments for the dam project, for example, which relates to the reservoir capacity of a comprehensive-utilization hub project for multiple purposes, should be undertaken by the department that will be served by that engineering project, such as, if the financing of the powerhouse of the station and its equipment is underwritten by the electric power department, so the investment for the dam project corresponding to the flood prevention capacity of the reservoir, should simply be undertaken by the water concervancy departments. Engineering concerned with the raising of the original channel navigation standard should be paid for by the transportation department, and financing for those navigation structures that are built to overcome the orig-

inally maintained navigation standards should be shared by various departments according to the measure of their benefits.

The total investments for comprehensive development of water resources on the main river segment of the Xi Jiang mainstream described above were initially budgeted when planned in 1985 for approximately 30 billion yuan. To the extent that agreements on sharing of engineering investments are improper, they will, to that extent, impair the smooth development of its water resources.

China: Water-Pumping Energy Storage Hydropower Station Constructed in Xizang

963A0034C Beijing SHUILI FADIAN [WATER POWER] in Chinese 12 Nov 95 No 11, pp 6,10

[Article written by Zhou Xiuling [6392 4423 3781] and Zhou Zhaoqiang [0719 2507 1730] Technical Office of the Wujing 3rd Hydropower Zongdui—3rd Hydropower Zongdui of the Chinese People's Armed Police Force, Chengdu, 610036]

[FBIS Translated Text] The Yamzho Yumco (Yangzhuoyong Hu, abbreviated to Yang Hu) water-pumping energy storage hydropower station, a key national "Eighth 5-Year Plan" engineering project, located within the boundaries of Nagarze and Gongar Counties of (Xizang) Tibet Autonomous Region, about 86 kilometers from Lhasa at 4,400 meters above sea level, is the highest water-pumping energy storage hydropower station in the world. This hydropower station uses the 840-meter fall of the large high-plateau closed lake, Yang Hu, and Yarlung Zangbo Jiang to generate electric power and for water-pumping energy storage. The watershed area of the Yang Hu is 6,100 square kilometers, the lake surface is about 664 square kilometers, and water storage volume is about 15 billion cubic meters. The station has four vertical-shaft triple-engine 22.5MW water-pumping energy-storage generators, and one 22.5MW routine impulse electric power generator unit and boiler in reserve for a total installed capacity of 112.5MW and a multi-year average power output of 104.12 million kWh. After the power station went into operation, its main services were for peak adjustment, frequency adjustment, and emergency standby for the Lhasa grid system.

The main structures that make up this power station hub are: a pressure-wall penstock 15.20 meters long installed with a pollution screen (4.0 by 6.0 meters) and working gates (2.5 meters by 2.5 meters); a round water-pressure intake tunnel 5,883.10 meters long with an internal diameter of 2.5 meters, and lined with reinforced concrete bricks; a differential pressure-regulated upper housing shaft 21.85 meters high with an internal diameter of 11.0 meters, and a vertical shaft 55.60 meters high with an internal diameter of 2.5 meters; pressurized steel tubing composed of an upper underground segment and a lower segment open to the surface, of which the buried segment is 754 meters long with an internal diameter 2.5 to 2.4 meters, encased in steel-lined concrete 0.6 meters thick, and the end of the buried tube segment has a D = 2.3 m butterfly valve imported from the U.S. The open tube segment, which lies along a mountain ridge, is 2,323 meters long with steel tubing 2.3 to 2.1 meters in diameter, and the entire line has 20 steel-reenforced concrete butresses and 173 supporting butresses. The main plant with installations is 87.48 meters long, 15.40 meters wide, 31.70 meters high. The 1st sub-plant, located on the downstream side of and parallel with the main plant, is 65.64 meters long, 10.72 meters wide and 9.96 meters high. The 2nd sub-plant, arranged perpendicular to the main power plant is 26.30 meters long, 15.50 meters wide and 19.70 meters high. The ball valve room, upstream from the main power plant, is 79.78 meters long, 8.80 meters wide, and 15.90 meters high. The switching station, on the downstream side of the 1st sub-plant, is 79 by 79 meters in size, at a surface height of 3,694.30 meters. The water pumping system has mainly an intake-channel pond 65 meters long, a low-lift pumping room 39.75 meters long, 16.50 meters wide and 24.90 meters high, and installed in it are 5 sets of 48LKXA-13 low-lift pumps, a sedimentation pool 140.0 meters long with a net-width 24.0 meters, and a 232.3 meters long energy-storage pump intake pipe with internal diameter of 2.0 meters. Inside the plant are steel-lined concrete pipes, and outside are steel-reenforced concrete pipes with 300 meter thick walls.

The Yang Hu power station, China's only high-water head triple-engine type water-pumping energy storage power station, has a high water head of 1,020 meters (including vertical water pressure). Its main power plant facilities are imported from the Austrian Elin-Voith Corporation. The long linear layout of the power station, the complex geological conditions, and the high technology requirements on the Tibetan plateau with its serious shortage of oxygen (the winter high is 48 percent), cold climate, dry air (the humidity gets down to zero), short construction season, and the bitter natural conditions, presented great difficulties for the design, engineering and construction management efforts.

The construction unit functions, organizational responsibility and a large part of the engineering duties for the station were assumed by the 3rd Zongdui of the Chinese People's Armed Police Force, and the design was undertaken by the Chengdu Survey and Design Acad-

emy of the Ministry of Water Concervancy and Electric Power.

In order to solve the urgency of electric power supply on the Lhasa grid and accelerate the economic development of Tibet, State approval was granted in August 1985 for the construction of the Yang Hu hydropower station. For various reasons work was stopped in July 1986, and approval for its resumption was formally issued by the State in August 1989. Units entered Tibet in September 1989 for the "ground leveling" preparation effort. Work formally began on 25 September 1990, and through heroic efforts, the penstock tunnel was cut through on 25 September 1994, 1 year ahead of schedule. The main power plant was sealed off on 24 July 1994, and main engine installation was begun on 12 December 1994.

On 5 August 1995, the examination and acceptance committee, composed of 19 units from relevant national departments and the local government, approved the test run of the No. 1 generator unit. On 29 August, water filled the penstock and the pressurized steel tubing, and on 31 August the No. 1 unit was water tested, and it ran normally. On 3 September, Vice Premier of the State Council, Wu Bangguo, as head of the central delegation, and leaders of the Tibet Autonomous Region, attended the celebration ceremony and ribbon cutting for debugging and start up of the 1st generator of the Yang Hu power station. The Yang Hu power station is a gleaming jewell on the summit of the earth.

With the blessings of the Party Central Committee and the State Council, under the leadership of the high-level departments concerned, with the generous assistance of the Tibet Autonomous Regional People's Government, the 3rd Hydropower Zongdui of the Chinese People's Armed Police Force resolutely shouldered the functions of construction units, organized and led the entire force, and together with the Chengdu Survey and Design Academy, the 2nd Hydropower Zongdui of the Armed Police, and the 4th Hydropower Engineering Bureau, redounded the "spirit of Yang Hu," overcame the altitude, cold, thin air, bedeviling natural conditions that present insurmountable difficulties for ordinary persons, and after 6 bitter years, put the first generator of the Yang Hu power station into operation 1 year ahead of schedule to bolster the solidarity of the people, stimulate the economic development of Tibet, and shower congratulations on the grand celebration of the 30th anniversary of the establishment of the Tibet Autonomous Region.

And now, the Yang Hu power station, once called "unthinkable" by western hydropower engineering experts, stands tall on the pinnacle of the world.

China: Hydropower Survey of Upper Huang He Foresees 14 Hydropower Stations

963A0034D Beijing ZHONGGUO KEXUE BAO [CHINA SCIENCE NEWS] in Chinese 22 Dec 95 p 2

[FBIS Translated Text] In early August 1995, the Northwest Survey and Design Academy of the Ministry of Electric Power and Qinghai Province Electric Power Bureau concluded their 27-day joint survey of hydrological resources of the Huang He segment upstream from Longyang Xia. The stretch of river upstream from Longyang Xia to the mouth of the Ngoring Hu is 1,140 kilometers long and drops 1,885 meters, and the survey found 14 locations where cascade hydropower stations could be built totalling as much as 6,600MW (equivalent to 5.1 Longyang Xia hydropower stations) for an annual output of 28.5 billion kWh.

This river segment, with its considerable hydropower resources, is flanked by stock-raising lands, areas having little or no electricity, and the forth-coming cascade stations, built in sequence, will be a great benefit to economic construction and to improving the livelihood of the pastoral peoples in the area. There will be very little resettlement of the people because very little land will be flooded.

China: Henan Province Becomes Central China's Largest Thermal Power Base

963A0023A Zhengzhou HENAN RIBAO in Chinese 27 Sep 95 p 1

[Article by Shao Xincai: "Henan Province Has Already Become Central China's Largest Thermal Power Base—The Generated Power Is Equivalent to More Than 7900 Fold Greater Than When the Nation Was Established, and This Year the Installed Capacity Will Reach 10 Million Kilowatts"]

[FBIS Translated Text] During the 46 years since the establishment of the new China, there has been rapid development in the electric power industry of Henan Province. There has been a 7948-fold growth in generated power, the output variable distribution network grew out of nothing, and at present 98% of the administrative villages throughout the province are connected with electricity. The generating equipment has developed from small power units in a few cities prior to 1949 to 17 large power plants with installed capacity of over 100,000 kilowatts thus becoming Central China's largest thermal power base.

On the eve of the founding of the nation, there was one normal thermal power plant in the entire province which had 15 power units which operated in isolation and directly generated 50 kilowatts or more of electricity. The capacity was less than 10,000 kilowatts, and the annual power generation was only 6.1 million kilowatt hours.

After the establishment of the new China, the ample coal resources and excellent social system caused the electric power industry dominated by the use of thermal power in Henan Province to develop rapidly like a fish getting to the water. In October 1953, the Zhengzhou Thermal Power Plant (now the Power Generation Institute of the Zhengzhou Thermal Power Plant) was first constructed and put into operation. It opened a prelude for the large-scale development of the electric power industry throughout the province. Large thermal power plants were successively constructed at Jiaozuo, Xinxiang, Anyang, Kaifeng, Pingdingshan, Danhe, Yaomeng, Shouyangshan, and Hebei. There are only 25 power units with single unit capacity of 100,000 kilowatts or more, and among these the Yaomeng Power Plant has installed four 300,000 kilowatt power units, and the Jiaozuo Power Plant has six 200,000 kilowatt power units so that they have become the two largest thermal power plants in Central China.

By the end of last year, the total installed capacity of electric power plants with 500 kilowatts and above throughout the province reached 8,473,550 kilowatts, and this year 1.58 million kilowatts will be put into production so that the scale of the installed capacity of the entire province can reach 10 million kilowatts so as to become one of the few large provinces in China with thermal power reaching installed capacity of 10 million kilowatts. Last year, the generated power of the entire province was 48.4865 billion kilowatt hours, equivalent to more than 7900 fold greater than at the initial period at the time of the founding of the nation.

At the same time that power stations were being constructed, power transmission lines were also being extended in every direction. Following the first electric network for the entire province just after liberation, that is, the Zhengzhou 35 kilovolt ring electric network, the first 110 kilovolt transmission line in the province from Zhengzhou to Loyang was constructed and put into operation in 1957, and by the end of 1981, China's first 500 kilovolt power transmission line was constructed from Pingdingshan to Wuchang so that Henan was joined into one large electric network with Hubei, Hunan, and Jiangxi, namely the Central China Electric Network. At present, the Henan Electric Network has already developed into a power network which principally utilizes 220 kilovolt lines, each power supply area transmits electric power to factories and mines through lines as fine as a spider's web, and its light shines upon thousands and thousands of households in the vast regions of the Central Plain.

China: Status, Prospects of Coal Resources

963A0A Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 22 Dec 95 p 2

[Article by Yang Qi, academician of the Chinese Academy of Sciences: "Status and Prospects of China's Coal Resources"]

[FBIS Translated Text] Although China's coal resources are plentiful, yet there are still many problems which cannot be overlooked. Based on the situations of coal production and consumption in China, China should maintain stable production, strengthen comprehensive utilization, use clean coal technology, and strengthen coal geology research.

The General Situation of Coal Resources and Problems Which Should Be Given Serious Attention

It is internationally recognized that coal is the bridge of a protracted energy source system leading to the future based on a regenerative energy resource. Based on estimations, if calculated according to the present annual mining rate of coal, the hard coal reserves in the world are sufficient to be mined for 170 years, and brown coal is sufficient to be mined for 390 years. Therefore, for a very long period of time in the future, coal shall still be the main energy source in the world, and the world's demand for coal will also continue to increase.

China's coal resources are plentiful, and its reserves occupy third place in the world. Of the more than 2,300 counties and cities throughout China, 1,458 have reserves of coal; there are 11 provinces which have resources greater than 100 billion tons, and among these the Ordos, Junggar, and (Turpan-Hami) are all extremely large coal basins with resources greater than 500 billion tons. According to predictions, the coal reserves are divided based on the different buried depths: 2 trillion tons at 1200 meters and less; 3.8-4 trillion tons at 1500 meters and less; and 5 trillion tons at 2000 meters and less. China is also a major coal-producing nation. In 1994, 1.186 billion tons of coal were produced occupying first place in the world. China is also a major coal-consuming nation, and so coal occupies over 70% of the energy consumed. At the end of this century, China's planned annual coal production is 1.4 billion tons, and it is planned that the annual production will be 1.75 billion tons by the year 2010, and 2.1 billion tons by the year 2020. At the beginning of the 21st century, approximately 75% of the increase in the demand for energy resources will still be satisfied by coal.

China's coal resources are plentiful, and yet there are still many problems which cannot be overlooked.

1. There is great imbalance in the geographical distribution of coal resources wherein there is more in the west and north and less in the east and south. Approximately 94% of the coal reserves are north of the Kunlun Mountains-Qinling-Dabieshan line, and only 6% is south of that line; 89% of the reserves are west of the Daxianling-Taihangshan-Xuefengshan line, and only 11% is east of that line. The distribution of types of coal is also unbalanced wherein 76% of smokeless coal is concentrated in Shanxi and Guizhou, 80% of coking coal is distributed in North China, and over 90% of low grade coal is in the Northwestern provinces. As a result, the situation of transporting northern coal south and western coal east will exist for a long time.

2. The rate of recovery is low, only 30% or slightly higher;

3. There is a lack of coal in the northeast, East China, Beijing, Tianjin, and Hebei, and the mining rate of coal in the central southern regions is great, the production reduction is voluminous, and the abandonment rate is rapid.

Prospects and Recommendations for Coal Resources

The several following points should attract our attention based on China's production and consumption of coal:

1. Based on China's economic development and the unbalanced distribution of coal resources, we should maintain stable production of coal for a long time in the eastern region as best as possible. Aside from searching for coal around the perimeters of old mining areas, covered regions still have potential for the discovery of new coal fields. Moreover, we should mine the as much as 15 billion tons of coal threatened by underlying karst water of Late Paleozoic coal fields in the eastern regions. In the long range, development of coal fields must be shifted to the west, and therefore, priority for development should be given to the coal fields bordering on the east such as Shanxi Province and the Ordos Basin, we should work hard to develop electric power stations near coal mines, and increase investments in coal field exploration and the building of mines; make great efforts to develop computer technology (including simulation and geological mapping); and develop high precision and high resolution geophysical techniques in exploration engineering .

2. Strengthen integrated utilization and use clean coal technology. Coal is not only fuel, but it is also a raw material for many types of industries. The waste of

coal is also manifested when high grade coal is used as low grade coal, and coal which can be utilized in industry is directly burned. Based on data from Germany, there are as many as 475 components in coal. The economic benefits of products which employ coal as the raw material for manufacture can be raised to a large extent. If we take coking coal as an example, aside from the main product of smelter coke, coal tar and coke-oven gas can also be obtained. Coal tar can be used to produce fertilizers, agricultural chemicals, synthetic fibers, synthetic rubber, plastic, paint, dyes, medicines, explosives, and other products. Aside from being mainly used in metallurgy, coke can also be used for making nitrogen fertilizer. Coke-oven gas can be used as the fuel for open-hearth furnaces and the coke oven itself, city coal gas, as well as the raw material of chemical fertilizers and synthetic fiber. The gasification and liquefaction of coal is even more important in the overall utilization of coal. China also has many types of coal which can make liquid fuel such as various types of humic coal, algal coal, and candle coal. For example, the tar yield of algal coal from Hunyuan in Shanxi Province reaches 32%; humic coal with high Liptinite contents, for example, the Liptinite content of some of the gas coal from the Zhunnan Coal Field is 15-26%, and the tar yield is 12-15%.

In order to reduce the environmental pollution created through the usage of coal and increase the usage value of coal, we should develop clean coal technology in many fields including increasing the washing amount of coal which will lower the sulfur content and mineral substance before the coal is put into use; develop molded coal and water-coal fluid; make gas and liquid fuels; and spread the usage of the vulcanization bed combustion technique in the burning of coal.

3. Strengthen geological research on coal. Strengthening geological research on coal is recommended in the following several areas.

1) Utilization of the theoretical methods of comparative sedimentology for research on the sedimentary environment of coal and coal-bearing rock systems, and integration of sedimentary facies analysis and coal facies analysis to study coal beds and predict the coal quality from the microcomponent gradations of coal; utilization of the theoretical methods of stratigraphic geology to show the space distribution patterns of sediment in the field of sedimentology and stratigraphy to establish sedimentation basins, especially the isochronous stratigraphic screenwork and evolutionary patterns of continental sedimentation basins; utilization of research on modern turf accumulation environments to study the control effects of the environments on the accumulation of coal as well as the coal accumulation patterns in different sedimentation environments.

2) Utilization of the view of developmental evolution to develop analysis of sedimentation basins, and carrying out comprehensive analysis of the paleostructures, paleogeography, history of settlement, and thermal evolutionary history of various basins as well as various parameters of formed mineral products so as to obtain an overall quantitative and qualitative conception of the sedimentary mineral products in the basins and search for coal near mining areas and new regions including pursuit of coal-rich regions and excellent effects of high grade coal with low sulfur and ash. This is also advantageous to the overall research and exploration of other mineral products in coal-rich rock systems such as fire clay, kaolin, germanium, gallium, vanadium, and oil and gas having genetic connection with coal.

3) Following the scientific and technological brainstorm projects of several 5-year plans, the majority of large basins of China such as the Sichuan, Ordos. Junggar and Tarim Basins as well as the East China Sea have already been verified to be large coal, oil and gas paragenetic basins. People no longer doubt the fact that the organic matter of coal-bearing rock systems can form oil, gas and coal-bearing basins and can also form oil and gas reservoirs which possess industrial value. However, we must still await further research on under what specific environments basins with accumulated coal can form oil and gas reservoirs with industrial value. Based on our understanding, oil detection work will be developed during the period of the "Ninth 5-Year Plan" in Northern Jurassic basins. This will involve investigation and integrated research on the genetic connections of coal, oil and gas in the same basin between the subsidence history, thermal history, coalification, and hydrocarbon formation geochemistry, and the alternation and coexistence of oil and gas forming sedimentary facies, as well as good opportunities for their formation and evolutionary patterns. As a result, we will be able to get twice the results with half the effort.

4) It should be stressed that coal petrographers and coal chemists jointly strengthen research on the nature of coal penetrating to the microcomponent level to address the present irrational mining of coal types, the waste of resources in using high grade coal instead of lower grade coal, the serious pollution of the environment with coal, and only being able to increase competitive power on the international market by providing high grade coal for export purposes so as to more effectively and better handle work on the selection of coal, coking coal blending, gasification, and liquefaction. At the same time, it is necessary to strengthen research on the accumulation mechanisms, storage conditions and

distribution of sources of pollution in coal such as sulfur, arsenic, mercury, aluminum, and cadmium as well as their trends and directions during the process of coal combustion. In this way, it will then be possible to not only employ pointed measures both during and after the use of coal but also prior to its being put into use. This will provide a basis for protective and control policies aimed at environmental pollution created from the use of coal.

Development of Fluidized-Bed Burning Technology in China

963A0036A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 5 Oct 95 p 7

[Article by Yue Guangxi: "Development of Fluidized-Bed Combustion Technology in China"]

[FBIS Translated Text] Fluidized-bed technology is a reactor technology developed within the area of chemical engineering. During World War II, the Germans developed and used it broadly in catalytic cracking reactors. In the 1960s, this technology was applied in the area of combustion. At first, it was blast bubbling bed technology, but after a few demonstrations the difficulties of this in combustion efficiency and full-scale operation were proven and the switch was made to circulating fluid bed technology. As before, it was the German Lurgi Company that developed the world's first 270 T/H circulating fluidized bed boiler. Because the circulating fluidized bed boiler showed its superiority in broad adaptability to fuels and control of combustion pollution as soon as it was produced, it received the high respect of the international energy business. Coming down to the present, this technology has already developed into several major branches of technology: the circulating bed boiler with external heat exchanger (EHE) represented by the Lurgi Company; the high circulating double efficiency hot cyclone tube boiler developed by Finland's Ahlstrom Company; the medium heat cyclone tube tower style circulating bed boiler developed by the Babcock Company of Germany; and the gas cold cyclone tube circulating bed boiler with integral external heat exchanger (Intrex) developed by Foster Wheeler in the United States. The boilers on line (outside of China) number close to 100, and the largest capacity under construction is 250 MW (electric power). The experience of the on-line circulating bed boilers shows that circulating bed boilers can burn wood chips, garbage, petroleum coke, on up to smokeless coal, lignite, and bituminous coal. Generally, NOx emissions are below 200 ppm, and the best performance is below 80 ppm. When Ca/S=2.0 or lower, the desulphurization rate is greater than 90 percent.

China is a great coal burning country. Most mines do not have washing facilities, but quality low-sulphur coal is concentrated in Shanxi, Inner Mongolia, Xinjiang, and Guizhou, far from the industrialized coastal and Yangtze regions, while in the industrially developed provinces, most of the coal produced locally is of low thermal value and high sulphur content. For this reason, circulating fluidized bed boilers are ideal facilities for local thermal power plants and power stations that provide for themselves burning local coal. For certain large-scale mainstay power plants far from high quality low sulphur coal producing areas, at the present time when the investment in desulphurizing the smoke is so costly, circulating fluidized-bed boilers are also the best choice.

Technical workers and engineering technology personnel in China have been putting their efforts into the blast bubbling bed and circulating bed technology that fit the conditions of China. Since the first oil shale burning blast bubbling bed boiler was put into production in 1964 until the 1980s, close to 4,000 different kinds of blast bubbling bed boilers have been put into operation (the largest having a capacity of 130 T/H), more than any other nation. After the late 1980s, we began researching and constructing circulating fluidized-bed technology. Along the way, we developed circulating fluidized-bed boilers ranging from 35 T/H to 75 T/H and numbering over 100 in service, with a 220-T/H boiler under construction. The technological routes vary according to the differences in producing plants and scientific research units. The jalousied two-stage segregated style with added cyclones circulating bed technology was devised by the Hangzhou Boiler Plant, the Wuxi Boiler Plant, and the Wuhan Boiler Plant working with the Chinese Academy of Sciences. The level-flow segregated circulating-bed technology and the second-generation water cooled nonconventional type cyclone tube circulating bed technology was devised by the Sichuan Boiler Plant and Qinghua University. The hot cyclone-tube circulating bed construction similar to the Ahlstrom and developed by the Jinan Boiler Plant was developed in cooperation with the Academy of Sciences and the German Babcock warm cyclone-tube tower style circulating bed technology imported by the Beijing Boiler Plant. Besides these there are other low output factions. For example, the triple whirlpool segregated circulating bed which was developed by the Wuzhou Boiler Plant and Qinghua University, or the buried-pipe circulating bed technology from the Northern Boiler North Factory and Harbin Industrial University.

Foreign circulating bed manufacturers, taking notice of the huge potential in China's combustion market and

of the fact that China still does not have manufacturing technology and operating experience with large-scale circulating beds, have moved aggressively on China. Ahlstrom led off by selling China the first 410-T/H, 100-MW class circulating bed, now being installed in Neijiang, Sichuan. And it transferred manufacturing authorization for a 220-T/H, 50-MW circulating bed to the Harbin Boiler Plant, and they now have orders for seven units from the Dalian Chemical Industry Company, the Hangzhou Thermal Power Plant, the Maoming Petroleum Industry Company, etc. Among these, the 220-T/H furnace of the Dalian Chemical Industry Company is expected to carry out trial operations this year. America's Foster Wheeler has transferred manufacturing authorization to the Dongfang Boiler Plant for its water-cooled cyclone-tube circulating bed (Intrex), and it has found its first customer in Ningbo, Zhejiang Province. The Beijing Boiler Plant mentioned above (Yuannan plant) has obtained a Babcock middle warmth cyclone-tube circulating bed from the Rely Stoker Company (U.S.), and after it has been successfully put into operation at the 75 T/H level, it is planned to have a 410-T/H class circulating bed boiler at Jixi.

The rapid development of the economy brought about by 10 years of reform and liberalization leaves the energy industry as a bottle neck for hindering the continued development of the economy. No matter whether from the perspective of raising the combustion efficiency of low-grade coal at present or the perspective of the long-term protection of the environment, this is a key technology that must be developed vigorously. The cost of manufacturing domestically-developed mid- and small-scale circulating beds is low and such construction is easy to expand. However, investment in scientific research is insufficient and experience lacking, so there are pervasive shortcomings in severe wear and tear, unstable load, and incompatibility of accessories. The State Planning Commission for Economy and Trade has, since 1994, supported a movement away from the main force circulating bed boiler types used presently by small- and middle-sized power plants to implementing perfected 75-T/H circulating bed demonstration projects. Looking at questions related to boiler type from the perspective of technology, it will carry out improvements in cooperation with scientific research units. For example, the Sichuan boiler plant and Qinghua University adopted a farsighted and important improvement in response to the efficiency problems of the original level-flow segregated circulating bed segregated vessels. Its segregated nature allows it to approach the cyclone tube, and its structure is also extremely well suited to integration and upscaling; experts see it as a superior plan that has the greatest potential for upscaling in China and can compete with foreign technology. This demonstration boiler will be fired up and put through test operations in October of this year. The State Planning Commission, the State Economy and Trade Commission, and foreign manufacturers are paying close attention to how this demonstration boiler goes. The Hangzhou Boiler Plant and the Academy of Sciences have also carried out corresponding investigations into the structure of the combustion chamber and the segregated performance of the second level in their model. A demonstration boiler of the improved model could be in operation this year. From the perspective of management, the State Economy and Trade Commission is aware that the deficiencies of domestically-produced circulating fluidized beds is not entirely a matter of the boilers themselves and that the fitting of complementary equipment and the planning and installation of boiler islands have an important effect. Therefore, in the implementation of demonstration projects, they have adopted the new mode of contracting the entire boiler island. This is an important measure for the 10-year development of China's circulating bed technology.

In the process of developing domestically-produced large-scale circulating fluidized-bed boilers, there is always a significant contradiction in introducing an assault from outside. On the one hand, researching and making circulating beds in this country can never catch up with the demand from the development of the energy industry, and the total investment by the state in circulating bed engineering is less than that of any single foreign boiler company. On the other hand, because of the development of China's market economy, every sector, not being under unified control, has spent much foreign currency to bring in licenses to manufacture foreign circulating beds. Their cost is generally three to five times that of domestic products of the same capacity. At the same time, this kind of importation cannot be tied in with the engineering and scientific research personnel domestically whose experience is with the mid- and small-scale circulating beds. Thus, even "digesting" and "absorbing" foreign technology is problematic, to say nothing of development. China's boiler industry will always be in the position of being of a "fabrication workshop." The experience of history already proves that it is not a matter of our engineers and technicians lacking intelligence and talent. Have not the load problems and other issues occasioned by the power sectors' importing so many foreign boilers been solved by Chinese testing personnel when the foreigners were at a loss for what to do? On the matter of the development of circulating fluidized beds it is actually the foreign companies that have greatly respected the slow but steady progress of Chinese technicians. Yet certain management sectors in China declare arbitrarily that domestic circulating fluidized-bed boilers

won't do, that imports are the only answer. Under the conditions of the present market economy, neither shutting the gates and doing research nor importing blindly are correct solutions. Circulating fluidized-bed technology is a developing technology; China should have a cheap and reliable circulating fluidized-bed technology that is suited to Chinese conditions. This technology should take into account the character of China, absorb the useful parts of foreign technology, and join the two together. In this regard, certain research and production units in China and some farsighted foreign companies are presently carrying out some beneficial experiments. For example, Qinghua University and the Sichuan Boiler Plant have entered into an agreement with Germany's LLB Company according to which experience with Qinghua's second-generation circulating bed technology and LLB's large-scale circulating bed will be combined in order to develop and manufacture in China a circulating bed boiler and boiler island system that is suited to China. LLB Company, having recognized the limitations of both the Lurgi circulating bed it had developed and the Circufluid circulating bed, and seeing the market potential of the second-generation circulating bed from Qinghua and Sichuan, accepted a program that would take the Chinese technology plan as its blueprint. This joint effort received the vigorous support of the State Planning Commission Science and Technology Office and at an appropriate juncture will be included in the "nine five" plan to tackle key problems. The Thermal Physics Research Institute of the Chinese Academy of Sciences has a similar idea for cooperation with a Japanese company.

As with any other new technology, the market will decide on circulating fluidized-bed technology and the development of products, as well as the competition between different schools of technology. No matter whether it is brought in from outside or produced domestically, in the end we have to look at the ratio between price and performance. The price of imported technology will never get any lower. The performance of Chinese technology still has plenty of room for improvement. The only remaining problem is: time. The task laid before us is how to improve domestically produced circulating beds in the shortest time possible, to capture the thermal electricity market first and then tackle the electric power market.

China: Shenfu Daliuta Coal Mine Begins Production

963A0036B Beijing RENMIN RIBAO in Chinese 7 Jan 96 p 1

[Article by Lie Xieyang: "The Daliuta Coal Mine in Shenfu Begins Production: China's Largest Modernized Mine; Annual Projected Output of as Much as 6 Million Tons"]

[FBIS Translated Text] Telegram from Shenmu, Shaanxi, 6 January. This paper's correspondent Liu Xieyang reports: The first year of the "Ninth 5-Year Plan" has just begun, and from the Dongsheng Coal Mine in Shenfu in Western China comes very exciting news: the largest ultralarge-scale modernized coal mine in the entire country, the Daliuta Coal Mine, was formally completed and put into production here today. Shining black gold passed through the high-speed automated conveyer belt from the work face to outside the mine and filled the waiting trains in a steady stream to be shipped all over the nation.

The Dongsheng Coal Mine in Shenfu is situated in the Yulin region of northern Shaanxi and Ih Ju Meng in Inner Mongolia, with proven coal deposits of 223.6 billion tons, one-fourth of China's total coal deposits. The coal here has low ash, low sulphur, and low phosphorus; it is close to the surface and easy to mine. It is a very ideal important natural resource base for China. As far back as 1989 large-scale construction was begun here, now called the "Shenhua Project." At present, a modernized mining district is taking shape. On the basis of the plan already approved by the state, the entire project will be basically complete by 2010, by which time a 60-million ton coal mine will be set up, close to the 900-km Shen-Huang (Shenmu—Huanghua) railway, the Huanghua Port with its corresponding oceangoing fleet, which can handle 35 million tons per year, and the Kengkou Power Plant. The trend is toward a total investment of about 35 billion yuan. "In the south there is the Three Gorges; in the North, Shenhua"; this project is second only to the Three Gorges dam as an engineering project straddling the centuries.

The Daliuta Coal Mine that went into operation today is the first mine constructed in the mining district. Its annual projected capacity is 6 million tons, and for the 20,601 working faces in the mine a complete set of the most advanced foreign mining equipment was imported. The daily production will reach 12,000 tons, the conveyor belts are 4.6 kilometers in length, it is entirely automated, high in output and high in effectiveness, as high as 23.8 tons per worker for the whole workforce, right up at the advanced world standard. Its entry into production symbolizes the first cannon shot of the Dongsheng Coal Field in Shenfu. China's coal mine construction has taken a great heartening step toward modernization.

[Photo caption: Comprehensive extraction work proceeds intensely at Daliuta.—Photo by Li Zhenjun.]

China: World's Largest Polyacrylamide Production Base Built in Daqing Oil Field

963A0021A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 18 Nov 95 p 1

[Article by Huo Jian: "China Builds the World' s Largest Polyacrylamide Base"]

[FBIS Translated Text] The reporter Huo Jian reports: Each injection of one ton of polymer can increase the yield of crude oil from oil wells by over 150 tons. This has been called the second initiated Daqing Oil Field project of "repeated importance" of the Daqing Oil Field Chemical Assistant Factory Polymer Project. On 15 November, qualified polyacrylamide products were produced at its terminal installation thus taking a great stride to become China's as well as the world's largest polyacrylamide production base with an annual output of 50,000 tons of polymer dry powder. This signifies that China has already mastered the key technology for transforming "water-drive oil" into "chemical-drive oil," as well as realized the industrial application of this technology for the first time in the world.

Polymer-drive oil is a high level and new technology which employs the water viscosity of polymer increased injection oil wells to raise the recovery ratios of oil fields, and it is an important measure for entering the high water content later development stage in terms of especially large sandstone oil fields such as the Daqing Oil Field. This technology began to be researched and developed abroad in the 1930s, and to date, it basically remains in the stage of laboratory numerical simulation. At the end of the 1980s, the Daqing Oil Field began research on the tertiary oil recovery method for polymer oil extraction. Area tests showed that the injection of polymers can raise oil field recovery ratio by 10%, and it can reduce the water contents of oil wells to the maximum limit, and lower energy consumption. A few days ago at the Lamadian Oil Field, I saw that the two polymer-drive test areas of the main oil field of the Daqing Oil Field which had already been injected and opened for over 20 years and which had formally begun to inject polymer liquid in 1994 have now had their overall water contents decrease from 94.1% to 87.6%, and the wellhead daily production of oil more than doubled from 639 tons to 1,343 tons.

On the basis of carrying out extensive feasibility demonstrations, in February of 1992, the Daqing Oil Field submitted to the State Council for approval to construct this important project which has benefits for the present as well as the distant future. The total construction area of the already completed polymer project is 167,800 square meters, there are 16 various types of production installations, and the entire project was designed and constructed by China.

Experts have pointed out that the overall completion and commissioning of this project has important significance for the Daqing Oil Field to realize the strategic goal of extending the world's record of 20 years of steady production of over 50 million tons or more of crude oil to the year 2005, as well as the strategic situation of China's oil industry being "stable in the east and developing in the west."

China: Four Oil Companies To Jointly Develop Tarim, Junggar Oil Fields

963A0021B Urumqi XINJIANG RIBAO in Chinese 16 Dec 95 p 1

[Article by Zhang Wenye: "Tarim and Junggar Basins To Launch the Great Battle for Oil Next Year—Four Major Oil Contingencies Including Daqing Will Push Into the West"]

[FBIS Translated Text] Dispatch from Kuerle. The correspondent Zhang Wenye reports: Beginning next year, the four oil contingencies of the Daqing, Shengli, Huabei, and Sichuan oil fields will push into the west, separately going into certain regions of the Tarim and Junggar basins to participate in the oil exploration and exploitation. This was announced recently by the China Oil and Natural Gas Corporation at the Western Oil Exploration Region Oriented National Oil Field Bidding Conference.

The Oil and Natural Gas Corporation decided to increase its Western area exploration forces, and expand its region in the West during the period of the "Ninth 5-Year Plan" and the next 15 years. Focus will be placed on finding high performance oil fields in the Tarim and Junggar basins which possess the greatest potential for oil and gas so as to transform as quickly as possible the Western strategic successor area into a realized successor area.

This is a move of a strategic nature. The Corporation decided to utilize the new market system as well as the methods of risk bidding and individual reaping of benefits so as to attract talented persons, technology, and funds from Eastern oil fields, invest in the exploration of oil in the main battlefields of the Western area, and launch the great battle in the Western area. This will consequently change the former closed type situation of "restricting activities to certain areas" so as to form a new strategic oil situation dominated by Western area oil fields with participation by Eastern oil fields and investments from foreign oil companies.

The Daqing, Shengli and Huabei oil fields separately won bids for the Northwestern, Southwestern, and Eastern regions of the Tarim Basin, an area covering 117,000 square kilometers. The Sichuan Oil Field won the bid for the Southern rim area of the Junggar Basin, an area covering 17,000 square kilometers.

China: Microbe Injection Technology Used To Increase Oil Production

963A0021C Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 15 Dec 95 p 2

[Article by Ma Chunyuan: "The Institute of Microbiology of the Chinese Academy of Sciences and the Oil Fields Administration of Jilin Province Cooperate in Using the Microbe Single Well Throughput Technique To Increase Crude Oil Production By More Than 15,000 Tons"]

[FBIS Translated Text] The reporter Ma Chunyuan reports: The new technique of microbe injection of single wells was jointly developed by the Institute of Microbiology of the Chinese Academy of Sciences and the Oil Fields Administration of Jilin Province. They constructed a total of 16 wells at the No. 3 Oil Extraction Plant at Fuyu in Jilin Province from June 1992 to the end of May 1995. The success rate reached 79%, the average increase in oil extraction was 204%, and the increase in the production of crude oil was 15,375.4 tons. Recently, this achievement won a second place Scientific and Technological Advancement Award of the Chinese Academy of Sciences.

The utilization of microbes to raise oil extraction rates is a high technology promoted internationally for increasing the production of crude oil. It is based on the ecological principle of the mutual adaptation of organisms and environment wherein the oil reservoir is taken as a huge biological reactor and the activities of the microbes and their metabolin release the oil retained in the crevices of oil rock. As a result, the goal of increasing the oil extraction rate is attained. Wang Xiuyuan, a research fellow of the Institute of Microbiology at the Chinese Academy of Sciences who has engaged in research on subterraneous fermentation of microbes for many years, cooperated with the Daqing Oil Field, and on the basis of the completion of a key task of the State's "Seventh 5-Year Plan," coordinated with related personnel of the No. 3 Oil Extraction Plant of Fuyu during the "Eighth 5-Year Plan" in using screened bacteria and indoor simulated tests based on local oil reservoir conditions to successfully develop a new single well throughput technique wherein microbes are given added nutrients by means of saccharic raw materials. Good strains of bacteria and nutrients are injected into an oil extraction well with suitable conditions, the well is closed for a period of time to allow the microbes to propagate and proliferate inside, and then afterwards oil extraction is restored. The advantages of this technique are that the geological conditions and oil extraction history of a single well are easier to understand and master, there are few disturbance factors, the success rate is high, and the economic benefits are noticeable. Calculating based on 1100 yuan per ton of commercial oil, in 3 years the No. 3 Oil Extraction Plant of Fuyu attained net profits reaching 14,783,000 yuan by using this technique.

The majority of oil fields in China have already entered into the middle and later stages of oil extraction, and the existing secondary oil recovery technology is only able to extract one-third of the underground crude oil. Therefore, development of new oil extraction techniques is urgently awaited. The successful research of the new microbe single well throughput technique has opened up a new avenue for slowing down the rate of oil production diminishing in old oil fields as well as realizing high and steady production.

China: Success in Using Wave Power To Generate Electricity

96P30161A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 27 Nov 95 p 1

[Article by Wu Hao]

[FBIS Summary] Factory Director, Yang Jie, of the Hu County Packing Technology Research Institute and the Hu County Zhonggong Machinery Plant in Shaanxi Province recently developed the "rotary-arm star-wheel speed variator," an energy converting equipment to mechanically convert wave power to electricity. The equipment is said to be the first wave power converter in the world. It has been successfully tested in the ocean in Tianjin. Yang has already signed an agreement with the Tianjin Oceanological Technology Institute to jointly develop the eight-kilowatt pendulum wave power experimental station, which is one of China's "Eighth 5-Year Plan" key projects. Fabrication tests conducted in the laboratory indicate that the experimental station operates well; and the station's automatic control unit, power supply and power storage equipment all meet the designers' requirements.

The experimental station has been shipped to the marine test base at Xiaomai (wheat) island in Qingdao City for pilot trial. Yang's invention will be significant to China in relieving China's energy shortage problem.

China: Thirty-kW Wind-Solar Power Generating System Developed

96P30161B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 22 Dec 95 p 2

[Article by Chen Xiechuan]

[FBIS Summary] The Electronics Engineering Institute of the Chinese Academy of Sciences (CAS) recently developed a 30-kW wind-solar light combination power generating system that can be used in areas having abundant wind and solar energy but no electric grids and also in the isolated islands.

The generating system contains five 5-kilowatt (kW) wind power generators, an assembly of 5040-watt solar batteries, 110 pieces of 1000-ampere-hour/2-volt built-in plumbous acid storage batteries, a 30 kilovolt-ampere three-dimensional dc-to-ac converter, a wind power/solar power control system, an ac-dc power distribution system, a data collecting and processing system, and a spare diesel generator. The system has been used in China for about 10 months. The five 5-kW wind power generators of the system supplies electricity through the ac-dc-ac operating system and use the dc cycle to recharge the storage batteries. In order to maintain a sustained recharging of the storage batteries and avoid overcharging of the batteries, the wind power generators operate in their highest efficiency by adopting the best control method—the blade tip speed ratio control—to produce the largest amount of energy while the storage batteries are not fully charged and automatically convert themselves to voltage-stablizing operation while the storage batteries are fully charged. The system is especially important in the situation of the days without wind and light because the electricity stored in the batteries will be able to guarantee a good supply of electricity for four to five days; and if it is needed, the spare diesel generator will also start operating in order to provide supplemental electricity.

China: New Energy Technology Development Plan in Ninth 5-Year Plan, Year 2010

96P30165A Chongqing XIN NENGYUAN [NEW ENERGY SOURCES] in Chinese 5 Feb 96 Vol 18 No 2, p 49

[Article by Huan Shunli]

[FBIS Summary] The Chinese Association of Power-Generating Equipment has just laid out the "China's Power-Generating Equipment Technology Development Plan in the 'Ninth 5-Year Plan' Period and the Year 2010." The following subjects are related to new energy technology development plan, which include:

1) Research and manufacture wind power power-generating equipment for solving the power shortage problem in remote areas, pastoral areas, and other specific areas; expand the use of one hundred-watt small wind power generator and 1-10 kW wind power/diesel oil power-generating system; develop and put into application wind power power-generating network (field), and at the same time start researching wind power equipment with higher power capacity (700 kW).

2) Vigorously develop solar energy power-generating technology and geothermal power generator and study the technology of 30 kW solar power station imported by Xizang; pay great attention to trends of solar energy battery research and development (R&D) and develop new-generation geothermal power generator suitable for geothermal power generation.

3) Research and manufacture tidal power generator with multiple operating purposes.

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25 June 96